THE DYNAMICS OF PUNJAB AGRICULTURE

by

A. S. KAHLON
S. S. KAHLON
J. L. KAUL
D. S. SIDHU
A. C. SHARMA
P. C. DEB
H. S. AULAKH

081

PRICE Rs. 2.50

B AGRICULTURAL UNIVERSITY
LUDHIANA

Personal

Reginald Rowe

THE DYNAMICS OF PUNJAB AGRICULTURE

by

A. S. KAHLON
S. S. KAHLON
J. L. KAUL
D. S. SIDHU
A. C. SHARMA
P. C. DEB
H. S. AULAKH

Department of Economics & Sociology
PUNJAB AGRICULTURAL UNIVERSITY
LUDHIANA
1972

Editor Research : **Dr K. L. Dua**
Editorial Consultant : **Dr K. S. Bedi**

Scientific & Research Library
No. 181
3 JAN 1985
C.F.T.R.I. Experiment Station. LUDHIANA-6

PRICE Rs. 2.50

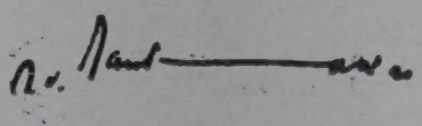
Printed by the Press Manager at the P.A.U. Press, Ludhiana, and published by the Directorate of Research, Punjab Agricultural University, Ludhiana (January, 1972)

FOREWORD

The first edition of *Dynamics of Punjab Agriculture* was published by Dr A. S. Kahlon and his colleagues in 1966. It has since been exhausted. Keeping in view the demand for this publication, and its importance in framing agricultural policies the authors have updated this publication. It would be useful for the policy-makers, teachers and the research workers as a reference book.

It brings out significant changes that have taken place in the Punjab in the land-use pattern, structure of the farm organization, foodgrain market structure, demand and supply situations for major agricultural products and modernization of the Punjab Rural Society.

I am sure this publication will be highly useful not only to teachers, research workers and officials and public men, but also to others who are interested in the welfare of the peasantry of the Punjab.



(M. S. Randhawa)
Vice-Chancellor
Punjab Agricultural University

CONTENTS

CHAPTER I
Modernization of the Punjab Rural Society 1—6

A Progressive State 1
Modernization of the Rural Society 2
Caste Hierarchy 3
Occupational Mobility 4
Economic Relations 5
Community Social Structure 5
The Emerging scene 6

CHAPTER II
Recent Technological Developments in the Punjab 7—20

Improved Varieties 7
Fertilizers 8
Pesticides 12
Irrigation 14
Farm Power 15
Electricity 16
Farm Machinery 18

CHAPTER III
Changes in the Land-use Pattern 21—30

Area under Forests 22
Land not Available for Cultivation 24
Culturable Waste Land 24
Fallow Land 24
Net Area Sown 25
Area Sown more than Once 25
Total Cropped Area 25
Intensity of Cropping 25
Changes in Cropping pattern 26

CHAPTER IV
Agricultural Growth-Rates 31—50

Production 32
Productivity 35
The Relative Contribution of Various Components to the Agricultural Growth 43
Differentials in Productivity Growth 44
Low Growth Areas 50

CHAPTER V

THE IMPACT OF FARM TECHNOLOGY ON FARM SIZE, LAND TENURES AND RENTS IN THE PUNJAB 51—59

THE IMPACT OF FARM TECHNOLOGY ON THE FARM SIZE 52
SHIFTS IN TENURIAL RIGHTS 53
ANNUAL RENTAL VALUE OF LAND 55
CASH AND KIND RENTS 57
SHARING OF INPUT COSTS 57
CONCLUSIONS 59

CHAPTER VI

DEMAND AND SUPPLY PROJECTIONS FOR MAJOR AGRICULTURAL COMMODITIES 60—94

DEMAND PROJECTIONS 60—70
THE BASE-PERIOD CONSUMPTION 61
ESTIMATE OF INCOME PER HEAD 63
ESTIMATES OF INCOME ELASTICITIES OF DEMAND 64
ESTIMATED DEMAND FOR SELECTED COMMODITIES 67
NON-HUMAN CONSUMPTION 70
SUPPLY PROJECTIONS 74—89
ACREAGE 75
IRRIGATION 76
FERTILIZERS 77
IMPROVED SEEDS 78
PLANT PROTECTION PRACTICES 78
PRODUCTION OF VARIOUS CROPS 78
MARKETABLE SURPLUSES 89

CHAPTER VII

THE DYNAMICS OF FOODGRAIN MARKET STRUCTURE IN THE PUNJAB 95—109

THE PERIOD OF SLOW DEVELOPMENT (1960-61 TO 1965-66) 97
THE PERIOD OF FAST DEVELOPMENT (1966-67 TO 1969-70) 97
CAPACITY OF THE MARKET YARDS 98
THE NUMBER OF PROCUREMENT CENTRES 99
MARKET LABOUR 99
THE CLEANING OF PRODUCE 100
GRADING AND STANDARDIZATION 100
TRANSPORTATION 101
NUMBER OF COMMISSION AGENTS 103
STORAGE 105
PROCESSING 107

CHAPTER I

MODERNIZATION OF THE PUNJAB RURAL SOCIETY

AFTER the reorganization of the erstwhile Punjab in 1966, the area of the new State shrank to 50,378 sq. kilometres owing to the formation of the separate Haryana State and because of the transfer of some of the area to Himachal Pradesh. The present population of the State is 13,472,972, indicating an increase of 21 per cent during 1961-71. The sex ratio in the State has shown a small rise from 854 females per 1,000 males in 1961 to 873 females to 1,000 males in 1971. The density of population per sq. kilometre has also risen from 221 in 1961 to 268 in 1971. The birth-rate in the State declined from 33.50 per thousand in 1962 to 27 in 1970. About fifty per cent of the total population is in the productive age group (15-59). The death-rate decreased from 11.17 per thousand in 1962 to 8.17 in 1967. The people in the State have the longest life span in the country, i.e. 53 years. The literacy percentage is 33 .39 against 26 .7 per cent in 1961. The percentage of population living in rural areas is 77, against 33 per cent living in over 109 urban centres.

A Progressive State

Although the geographic area of the State is smaller than that of many other States of India, in economic development it ranks among the most highly developed States of the country. The State has set up many medium and small-scale industrial units, their number being 4,414, employing 105,924 persons.

In the field of agriculture, its achievement has been spectacular in the recent years. Green revolution has been a reality in the Punjab. The per-hectare wheat yield in the State is comparable with that in any developed country of the world. In fact, the yield of wheat per hectare in Ludhiana in 1969 was 30.4 quintals, and it was the highest in the world.[1] This was made possible by the modernization of agricultural operations in the State. The introduction of high-yielding crop varieties, mechanization in various forms, irrigation, the increased use of non-traditional inputs, such as fertilizers, pesticides etc. have changed the economic contours of the rural Punjab. Leaving aside other farm machineries, tractors alone number 25,000 in the State.

1. Monthly Bulletin of Agricultural Economics Statistics, December 1969 Vol. 18, F.A.O., Rome.

There has also been a continual rise in the income per head in the State. It rose from Rs. 307 in 1961 to Rs. 854 in 1970 (at current prices). In fact, the State's per capita income is the highest in the country.

Modernization of the Rural Society

In any society, economic modernization is always accompanied with the modification of the existing social structure. There are many signs that the rural society in the Punjab is under the modernizing influence of economic progress.

The spread of communication media in the State in the recent years is evident from the increase in the number of newspapers, radios and printing presses. The number of newspapers and periodicals published in the State increased from 478 in 1966 to 552 in 1969. Printing presses increased from 534 in 1966 to 897 in 1969. The number of radios, which was 682,053 in 1969, showed a threefold increase over that in 1965. The recent changes in the pattern of investment and expenditure by the farmers is evident from the following Table.[1]

	1966-67	1969-70
Farm investment	18% of gross income	22.54% of gross income
Income elasticity for farm investment	.73	.89
Family expenditure	35.77% of gross income	29.31% of gross income
Income elasticity for family expenditure	.56	.58
Litigation	2.54% of total family expenditure	1.14% of total family expenditure
Socio-religious expenses	8.1% of total family expenditure	16.64% of total family expenditure

The study showed that farmers were continually ploughing back a large part of their income for the improvement of their farm organization. On the other hand, the socio-religious expenditure was gradually increasing. Apart from the unproductive nature of this expenditure, the socio-religious functions served as an important recreational activity for the com-

1. Kahlon, A.S. and Bal, H.S. 1971. Factors associated with farm and farm family investment patterns. Mimeographed Report, Punjab Agricultural University, Ludhiana.

munity. As such, it could not be devalued completely. The well-to-do farmers, by making such expenditure, often shared their prosperity with other members of the community.

Instead of following the age-old customs and traditions, people were guided more by rational considerations in spending their income.

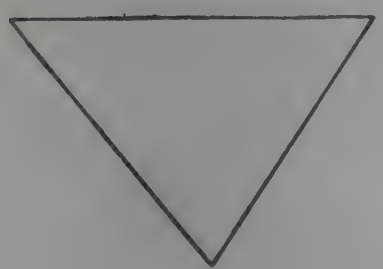
Again, the expenditure pattern showed that the people had a long-range motive behind it. The education of children, housing and better standard of living were the major emphases of the non-agriculturists, whereas the expenditure on agricultural implements, the purchase of modern farm inputs, and other farm improvements, the education of children and a better standard of living were the major concerns of the farmers.

There was a definite trend towards nuclear type of families in rural area which is an indication of the impact of urban life on the village people. A decrease in the size of families in the State is evident from the recent studies.[1]

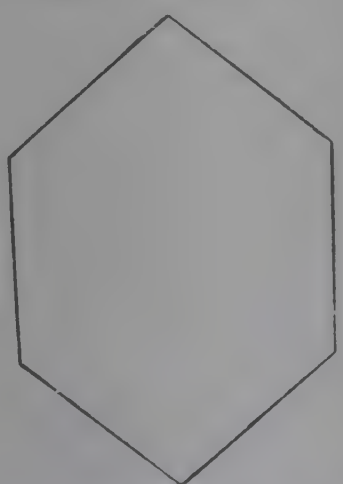
Caste Hierarchy

The shape of the caste hierarchy in the Punjab is different from what is noticed in other States. In the Punjab, it approximates the shape of a triangle, whereas in other States, it is generally a diamond shape, as illustrated below :

Shape of caste hierarchy in the Punjab



Shape of caste hierarchy in other States



The shape of the hierarchy is an indication that castes falling in the lower strata are fewer in the Punjab than elsewhere.

1. Deb, P.C. 1969. Farm mechanization and social change. Paper read at 10th All-India Sociological Conference, Delhi.

The hold of caste in the rural Punjab is also much less than elsewhere in India. In this State, the social distance among castes is decreasing and the caste rigidities are rapidly disappearing. The urge for social mobility among lower castes in the State, especially among the Harijans, is much stronger now. Rapid industrialization and urbanization, and the liberal traditions of the Sikh religion—all have contributed, in a large measure, to the flexibility in the caste structure of the Punjab rural society.

The Jat is the dominant caste in the State. Its members own and cultivate most of the village land. Besides the Jat, other castes cultivating some land are the Gujar, Rajput, Saini, and, to some extent, Harijans, but their number is much smaller. The Jats are a progressive community. They have shown to the world how hard work and perseverance help to convert sand into gold. They have made green revolution in the Punjab a reality. Their achievement, however, is not limited to agriculture. Their contributions to other spheres of social progress, such as education, defence, administration, industry and business are equally significant.

Occupational Mobility

In the sphere of occupational mobility, recent studies[1] indicate that the rate of inter-generational and intra-generational occupational mobility is increasing at a faster rate. This, in itself, is a sign of the changing attitudes and values, because in the past, the people generally held to their traditional caste occupations. It was also brought out in these studies that the rate of mobility was higher among the non-farming population than among the farming population. Since the change of traditional occupation of a lower caste gives rise to a change in its social status, it shows that the lower-caste people have been taking advantage of the changed economic situation to improve their status in the society.

A recent study[2] has shown that 'farming' as an occupation is considered most prestigious by both farming and various non-farming occupational groups of the rural areas. Whereas in many other states of the country, 'farming' is not given such a high rank, in this State, the modernization of agriculture has given it the highest prestige among all the occupations. Whereas

1. Agarwal, B.K. and Deb, P.C. 1971. Inter-generational occupational mobility in Ludhiana. *J. Res., Punjab Agric. Univ.* (accepted).
2. Agarwal, B.K. 1970. A study of occupational mobility in Ludhiana. M.Sc. Thesis, Punjab Agricultural University, Ludhiana.

there is a general tendency among the educated youth in other States to aspire for white-collar jobs, here it is farming and farm-orientated jobs for which all categories of people aspire.[1] Even a change of values is noticed in regard to factors that were considered to effect one's status in society[2]. Whereas in the past, caste was one of the most important referrents of status in the rural society, the present-day youth consider education the most important of all factors determining one's status in society. Parents also show great interest in giving their children high education.

Economic Relations

Caste, which was the most dominant institution of the rural society in the past, is losing its influence in secular spheres, and caste-based obligations are given less recognition in the economic life of the society.[3'4] The major economic relations are now regulated more through cash payments and in contractual terms rather than on traditional basis. The traditional *jajmani* system, which once regulated the socio-economic life of the rural people, is gradually being replaced by contractual relation. The situation is further aggravated by the inability of the occupational system within the local communities to meet the pressure of the rising population, and consequently, it leads to occupational outer-directedness of the castes which do not possess productive resources within the local community.

Community Social Structure

The community social structure has been influenced by mechanization of agriculture in the Punjab.[3'4] It has provided a new value system and a new outlook to community relations. The role of the members of a family has increased in the farm operation. The serving castes perform only those jobs for which the family does not posses the skill or on which it is convenient and cheap to employ labour. The local community is no longer well-equipped to cater to the replacement, repairs and upkeep requirements of farm machinery. Now the farmers have greater dependence upon urban centres for these services. They are thus shifting their occupational interests beyond the community boundry to strive for better economic opportunities. They are

1. Deb, P.C. and Agarwal, B.K. 1972. Occupational aspiration and socio-cultural background of postgraduate students. *Inter-discipline* (accepted)
2. Deb, P.C. 1970. Students' evaluation of factors determining social status. *Inter-discipline*, **6**: 247-53.
3. Kaushal, M.P. 1969. Mechanization of agriculture and community relations, Paper read at 10th All-India Sociological Conference, Delhi.
4. Deb, P.C. 1969. Farm mechanization and social change. Paper read at 10th Sociological Conference, Delhi.

becoming important agents and carriers of urban influence back to the community. Their relations within the community exhibit some degree of evaluative orientation of the modern industrial society rather than that of the tradition-bound peasant society. This is not the case only with farmers but with other social groups of the community. The residents live in the community to the extent it satisfies their bio-psychological needs and not for the welfare of the community. Mutual aid is now based on rationality.

Social activities and friendship bonds are not limited to kin-groups and one's own caste, but extends to other caste, community and occupational groups. People are now more receptive to new ideas and technological developments.

The Emerging Scheme

To summarize, the rural society of the Punjab is undergoing rapid change in its social and economic life. Economic values are gaining dominance over social values. This is perceptible in personal values, the mode of community participation, the urban-orientated behaviour and the rise of individualism among people. With the introduction of modern technology in the farm and the impact of industrialization and urbanization penetrating into various spheres of rural life, the role of traditional values is diminishing.

On the basis of the trend of modernization visible at present in the rural society of the Punjab, it is expected that with the same or higher rate of economic development, spectacular structural changes are expected in the State in the near future. One can forecast, and there are valid grounds for it, that the State will not remain a fore-runner in agricultural development only, but would be leading in 'social' modernization too.

CHAPTER II

RECENT TECHNOLOGICAL DEVELOPMENTS IN THE PUNJAB

THE recent developments in farm technology have revolutionized the agricultural industry of the State and have increased farm output manifold. For example, the production of foodgrains alone has increased from 2 million tonnes in 1950-51 to 6.5 million tonnes in 1969-70 in the Punjab through technological and economic changes.

These major changes are : (i) those which allowed shifts to new better yielding and most efficient production functions and (ii) those which allowed the producers to push out to higher output level along the traditional production functions. The variable influencing changes in the first category covered such technological development as the evolution of new crop varieties and new plant types. The recent development of high-yielding varieties of *bajra*, rice, maize and wheat introduced new and more efficient production functions with steeper slopes and higher points of maximum yield. These production functions permitted higher output with the same or higher levels of other inputs. However, these were ultimately subjected to the operation of the law of diminishing returns. The variables effecting the changes in category (ii) included such inputs as fertilizers, irrigation, pesticides, fungicides, weedicides and new machinery and equipment. The response to these additional inputs increase the rate of output. But there was a limit to the possible total increase in physical as well as in economic sense owing to the operation of the law of diminishing returns. Both types of technological changes brought about an increase in the total agricultural output in the State and ultimately shifted the supply curve of these products to the right. We shall examine the role of these technological changes in increasing agricultural productivity in the Punjab State in this Chapter.

Improved Varieties

The Punjab farmers have brought about the green revolution in the State by readily accepting new improved varieties of crops and shifting to higher and more efficient production functions. The adoption of the Mexican wheats and dwarf paddy have been more spectacular than others, but they all have contributed to the recent increases in agricultural output. The

new varieties possess two distinct characteristics, namely dwarfness and disease resistance. Both these characteristics have much economic importance. The dwarfness of the plants ensures a higher intake of nutrients through the increased use of manures and fertilizers to obtain greater yields. The genetically inherited disease-resistant character reduces the probability of reduction in yield and of quality deterioration. These characters stabilize yields at higher levels per unit area.

Table 2.1 indicates the area under improved varieties of major food crops in the Punjab. The area under high-yielding varieties in 1969-70 increased by 240 per cent over that in 1967-68 in the case of rice, maize, *bajra* and wheat. The increased acreage under the high-yielding varieties of rice and wheat and the ultimate shift in the supply curve of these foodgrains can be readily identified.

TABLE 2.1

Area under high-yielding varieties of major food crops in the Punjab, 1967-68 to 1969-70 (000 hectares)

Crops		1967-68	1968-69	1969-70
Rice	..	17	26	72
Maize	..	29	49	52
Bajra	..	51	82	100
Wheat	..	621	1,194	1,502
Total	..	718	1,361	1,726

Fertilizers

Theoretically, it is profitable to extend the use of fertilizers, and for that matter of any variable input, till their marginal costs are equal to their marginal returns. Dwivedi[1] emphasized that the use of nitrogenous fertilizers in the Punjab was inversely related to their real cost and positively related to the irrigated area of the State. Simple production function for fertilizers, however, do not explain the interaction between

1. Dwivedi, H.N. 1967. A study of the demand for nitrogenous fertilizers in the Punjab. Ph.D. Thesis, Punjab Agricultural University, Ludhiana.

this input and other complementary inputs like irrigation. Miglani[1] has analysed the relationship between the number of pre-monsoon irrigations and the amount of nitrogen used on sugarcane (Fig. 1). This study indicates an optimum combination of nine pre-monsoon irrigations and 129.20 pounds of nitrogen for obtaining 318.64 quintals of Co. J 39 sugarcane per acre in the Punjab.

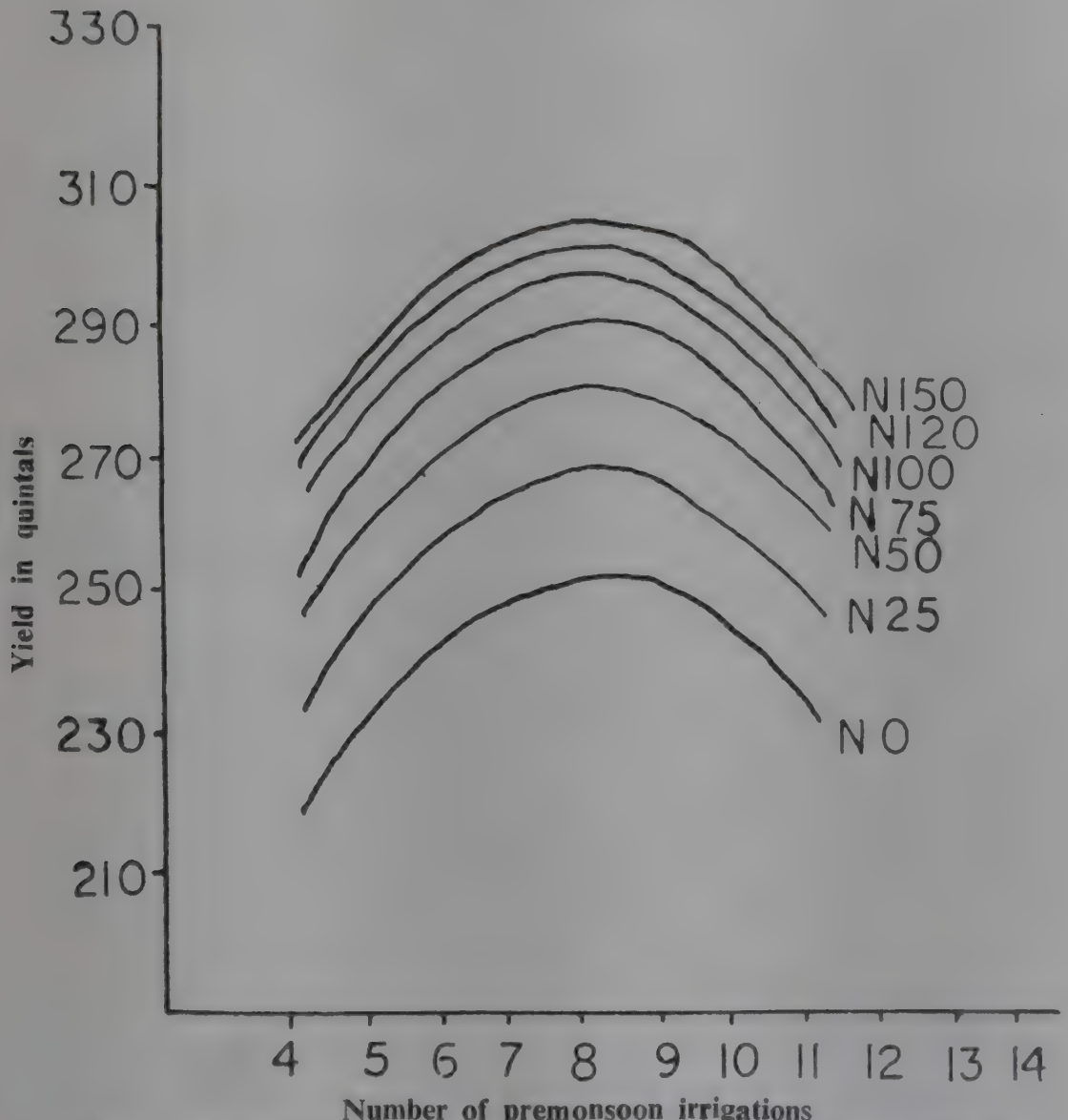


Fig. 1. Yield response of sugarcane variety Co. J 39 to irrigation

$$Y = 114.42908 + .0786197\ N + 32.220918\ I - .0022315\ N^2 - 1.775462\ I^2 - .004216\ NI$$

Individual fertilizer nutrients as well as other variables, such as the planting-rate and soil acidity, also interact to give

1. Miglani, S.S. 1966. An economic analysis of irrigation and fertilizer requirements for the sugarcane crop in the Jullundur District. M.Sc. Thesis, Punjab Agricultural University, Ludhiana.

curvilinearity in the production surface. Gupta[1] examined the response to the second interaction between phosphorus and nitrogen, holding potash constant at 25 lb. per acre on wheat in the Punjab (Fig. 2).

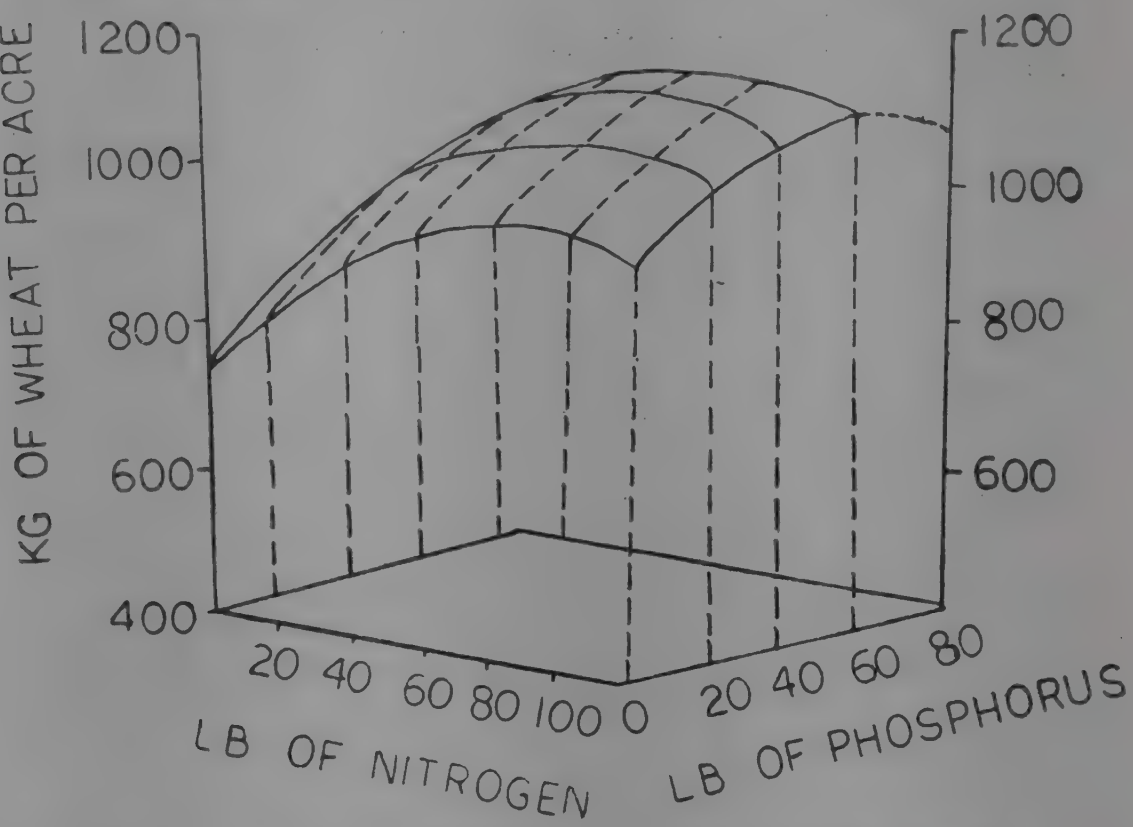


Fig. 2. Production surface for wheat variety C 273—predicted yields at 25 lb. of potash per acre.

TABLE 2.2

Distribution of fertilizers in the Punjab 1965-66 through 1969-70 (quantity in tonnes)

Fertilizers	1965-66	1966-67	1967-68	1968-69	1969-70
Ammonium sulphate	46,169	25,626	86,895	116,938	84,470
Ammonium sulphate nitrate	..	..	3,691	2,791	617
Urea	74	6,373	31,778	96,358	130,675
Calcium ammonium nitrate	167,939	185,641	210,911	236,848	219,407
Super-phosphate	21,282	12,887	25,934	56,394	50,460
Di-ammonium phosphate	..	5,356	19,256	42,662	15,514
Mixture*	761	1,233	5,838	17,280	32,306
Total	236,225	237,116	374,303	569,281	533,449

*Mixture means potash for 1965-66 onwards.

Source : The Punjab State Co-operative Marketing Federation and the Registrar Co-operative Societies, Punjab.

1. Gupta, B.C. 1966. Multi-factor analysis of fertilizer use on wheat in the Punjab. M.Sc. Thesis, Punjab Agricultural University, Ludhiana.

The findings of these researchers and those of others were communicated to the Punjab farmers and they made significant progress during the last decade in realizing their goals of increased production through the extensive use of various kinds of fertilizers. Table 2.2 shows the quantities of fertilizers distributed in the State during the period 1965-66 through 1969-70.

It will be seen from Table 2.2 that the total distribution of fertilizers made rapid strides in the period under consideration and it increased from 236,225 tonnes in 1965-66 to 533,449 tonnes in 1969-70 and this means an increase of 226 per cent.

In spite of the perceptible increase in the use of nitrogenous and phosphatic fertilizers in the Punjab, the individual farmers are far behind the optimum level of fertilizer use recommended for various crops. This has been evidenced by a study undertaken by Kahlon and Kaul[1]. They worked out the optimum fertilizer requirements for Kalyan Sona 227 wheat at various levels of its adoption in the Punjab, assuming the product price of Rs. 80 per quintal and compared it with the quantities of nitrogenous and phosphatic fertilizers available in the State in 1966-67 (Table 2.3).

TABLE 2.3

Optimum fertilizer requirements of wheat variety Kalyan Sona 227 and the total fertilizer available in the Punjab, 1966-67 (in tonnes)

Percentage area under Kalyan Sona 227	Optimum fertilizer requirements of Kalyan Sona 227		Total fertilizer available in the Punjab, 1966-67	
	N	P	N	P
60	107,564.37	57,371.97	43,791.00	10,412.00
70	125,491.72	88,605.97	..	..
80	143,419.10	101,263.97	..	..

This study indicates that the total fertilizer available in the State could hardly meet 40 per cent of the fertilizer requirements for the high-yielding wheat varieties. This analysis does not, however, take into consideration the fertilizer needs of the

1. Kahlon, A.S. and Kaul, J.L. 1968. Comparative study of economics of high-yielding varieties of wheat—Punjab State, *Indian J. Agric. Econ.* **23** (4) : 79-86.

farmers for other crops. This suggests that farm output can be further increased by increasing the supply of fertilizers in the State and making them available to the farmers at their doors. Keeping this in view, the Punjab State Co-operative Marketing Federation (Markfed) proposes to set up in the foreseeable future half a dozen more fertilizer factories at Dhuri, Morinda, Amritsar, Bhatinda and two other places in the State.

The use of micro-nutrients is not yet in vogue although the recent researchers in soils have pointed out their importance in increasing agricultural output in the State. The new high-yielding strains of wheat, producing at the level of 60 quintals per hectare of grain, remove 142, 49 and 162 kg. of nitrogen, phosphorus and potash along with 65, 208 and 318 gm. of copper, zinc and manganese respectively, whereas the old tall varieties of wheat removed 59, 29 and 67 kg. of nitrogen, phosphorus and potash respectively for 22 quintals per hectare of the wheat grain. The shift from the old to the new varieties of wheat which can withstand higher doses of fertilizers has created an imbalance of nutrients in the Punjab soils. This has led to increasing reports of zinc deficiency and a remarkable response to its use by field crops. This imbalance can be rectified by adding suitable doses of micro-nutrients, like zinc, copper, boron, molybdenum, etc., to the soil for the proper nourishment of the plants. The experiments have shown that the application of zinc phosphate at the rate of 59 kg. per hectare increased the yield of wheat by 13 quintals per hectare. It is hoped that the farmers would soon recognize the role of micro-nutrients in the modern technology of wheat production and adopt them for increasing their production per hectare.

The studies undertaken by the plant-breeders have indicated that the spraying of plants with hormones, like 'Cycocel', would open up new horizons in the technology of cash crops, like cotton. These hormones retard the excessive vegetative growth of these plants and stimulate flowering and fruiting. Their application results in an increase in the yield per acre of these crops. It has been found that the spraying of American cotton with Cycocel at the rate of 32 c.c. in 120 litres of water and that of the *desi* cotton at the rate of 50 c.c. in 120 litres of water, 75 to 90 days after sowing, increases their yields by 40-120 kg. per acre.

Pesticides

Pests and diseases are known to seriously damage and even annihilate crops, if adequate preventive and curative measures are not taken in time.

Pesticides include all the chemicals, dusts and sprays, which fall under the classification of insecticides, fungicides and herbicides. They serve to protect the animals, plants and stored grains against pests which tend to retard the efficiency of, or destroy, the production unit. Besides, the use of pesticides, fungicides and herbicides reduces yield uncertainty in agriculture and enables the producers to push on their production functions with higher units of other inputs. It has been estimated that the control of insect-pests of major crops in the Punjab, such as cotton, maize, sugarcane, potatoes, rape and mustard, benefit the farmers to the extent of 2,155 crores of rupees. These estimates are based on the assumption that 25 per cent of the area under cotton, rape and mustard, maize and sugarcane and 40 per cent of the area under vegetable crops, and *bajra*, groundnut and wheat (for field rats) covered by the pest-control measures. The crop-wise estimates of these benefits are shown in Table 2.4.

TABLE 2.4

Economic benefits of research on insect pests in the Punjab, 1966-67

Pests/crop	Cost of control operations per hectare (Rs.)	Additional return per hectare (Rs.)	Percentage area covered	Total area in the Punjab (000 hectare)	Total economic benefit (Lacs of Rs.)
Cotton	300	750	25	436	816
Rape and mustard	150	550	25	119	164
Sugarcane	200	250	25	285	178
Maize	175	650	25	444	722
Potatoes	200	500	40	14	28
Other vegetables	200	500	40	25	50
Field rats (in wheat, *bajra* and groundnut)	3	35-77	40	1971	197
Total	..				2,155

Source : Note on economic benefits of research on insect pests. Department of Zoology-Entomology, Punjab Agricultural University, Ludhiana, (unpublished).

It is estimated that if the recommendations made by the University experts for the control of various pests are strictly followed, there can be an additional income of over 80 crores of rupees with the current varieties at existing levels of inputs. Recent researches have pointed out the disadvantages that accrue to the farmers from a purely chemical pest-control measures. For example, the indiscriminate use of pesticides elevates the minor pests to the rank of major pests; leads to the resurgence of pests; results in the development of pesticidal resistance in

the pests; creates toxicity hazards to predators, pollinators, man and other animals; and pollutes the human environment. Research efforts is in progress to develop integrated pest-management programmes, which would be more economical and suffer less from the disadvantages which result from a purely chemical control approach.

Irrigation

In a semi-arid region, such as the Punjab, irrigation is one of the vital inputs for attaining higher level of agricultural productivity. The interaction effect of irrigation and fertilizers on crop yields are well known in the scientific world. It is because of this understanding that the Punjab farmers are making earnest efforts to supplement the irrigation available from the Government canals. They are becoming more and more interested in possessing independent and dependable sources of irrigation to increase the intensity of cropping on their farms. This objective is being achieved by them by exploiting the ground-water resources, by sinking tube-wells and installing electric motors and diesel engines for pumping water. A study undertaken by Bhatia[1] brought out that the cost of lifting water with an electric motor was cheaper than that with the diesel engine. The role of these machines in the economy of the Punjab farmers has become all the more important in the context of the green revolution. These machines are not only able to pump water to meet the enhanced requirements of the new crop varieties but also carry out other stationary farm operations, such as threshing and shelling of grain, chaffing fodder and crushing sugarcane. It is becoming exceedingly difficult to accomplish all these operations in time with the equipment operated manually or with animal power. The delay in the completion of one or more of these operations deteriorates the quality of the harvested produce. The increase in the number of electric motors and diesel engines for irrigation in the Punjab during the period 1965-66 through 1969-70 is shown in Table 2.5.

It will be seen from Table 2.5 that the number of tube-wells used for irrigation in the Punjab increased from 26,066 in 1965-66 to 87,562 in 1969-70. This increase works out to 336 per cent.

The Punjab State Electricity Board proposed to energize 2 lacs of additional tube-wells in the State during the Fourth Five-Year Plan to exploit the plentiful ground water. The Board expects this increasing trend to continue in the State even

1. Bhatia, J.S. 1965. Economics of pumping-sets, tube-wells, operated with diesel oil and electricity for different-sized farm situations in the Ludhiana District of the Punjab. M.Sc. Thesis, Punjab Agricultural University, Ludhiana.

TABLE 2.5

Number of tube-wells and other wells for irrigation in the Punjab 1965-66 through 1969-70

Particulars	1965-66	1966-67	1967-68	1968-69	1969-70*
Government	705	757	832	843	884
Private	25,361	30,137	43,659	62,018	86,698
Total tube-wells	28,066	30,894	44,491	62,863	87,562

*Provisional

Source : Director of Land Records, Punjab.

after the Fourth Plan and anticipates the number of tube-wells to increase to 156,000 by 1974 and to 300,000 by 1980. The increase in the supply of assured irrigation would further increase agricultural output in the State.

Farm Power

Farm power and agricultural productivity are closely correlated. Giles[1] found in respect of a few selected countries that the yield of major food crops per hectare were positively correlated with the available horsepower The horsepower comprised the aggregate from all sources, viz. human, animal and mechanical, available for agricultural operations. Although Giles[1] emphasized the need for a more thorough investigation into this relationship between yield and horse power input for developing a scientific base for programming the addition of mechanical power and equipment to the 'input-mix', yet his findings give added support to the view that more power was imperative for stepping up agricultural productivity in the developing State.

The basic objective of increasing the quantum of farm power is to raise the level of a worker's capability to do work. Unlike automation, the substitution of human component is not the major objective. A review of agricultural development in the State indicates that the increased use of power equipment is mostly orientated towards (i) the getting of various operations done in time to allow more intensive crop-husbandry practices and increased cropping intensity; (ii) the proper utilizing of inputs, like fertilizers, pesticides and water; and (iii) the reducing of drudgery and making the profession more attractive

1. Giles, G.W. 1966. Report on agricultural power and equipment subpanel 3, Manufactured physical and Biological Inputs, *World Food*, p. 49.

and acceptable to the educated and intelligent people. Pathak[1] has estimated that 1,379,200 horse power units of energy is available to the Punjab farmers for agricultural operations. Of this, human labour supplies 129,200 H.P. units of energy, bullocks 700,000 H.P. units and tractors 550,000 H.P. units. Bullocks thus, continue to be the major source of power for operations relating to agricultural production. The Punjab farmers are, however, taking to mechanised cultivation at a fast rate and it is hoped that the number of bullocks will ultimately be reduced owing to their partial replacement with tractors. Pathak[1] has estimated by 1980, the Punjab State would have 134,000 H.P. units of human effort, 500,000 H.P. units of bullock effort and 5,060,000 H.P. units of tractor work, accounting for a total of 564,000 units of power. A part of the energy supplied by these sources would be used for purposes other than agricultural operations. Assuming that 75 to 80 per cent of this power would be available for operations connected with agricultural production in 1980, the State would have over 1 horse power per hectare for over 4 million hectares expected to be under cultivation at that time.

Electricity

Electricity is a very convenient and satisfactory source of energy for operating various kinds of stationary equipment used on the farm and in the farmstead. The most commonly used device for converting electric energy into mechanical energy is the electric motor. Just as the tractors changed the pattern of field work on the farm, the electric motors are revolutionizing the work around the farmstead. The increased use of electricity has given the farmer more opportunity and time to use modern machines and methods in the production of field crops and has ultimately raised their incomes and standards of living.

The electrification of villages in the Punjab has also contributed to an increase in agricultural production. The pace of electrification of towns and villages in the Punjab is shown in Table 2.6.

The number of towns and villages electrified in the Punjab increased from 3,623 in 1966 to 5,712 in 1970, accounting for an increase of almost 57.5 per cent during the period under consideration.

1. Pathak, B.S. 1970. Some problems of mechanization of agriculture in Punjab. Punjab Agricultural University, Ludhiana, p. 5.

TABLE 2.6

Number of towns and villages electrified in the Punjab 1966 through 1970

Years as on 31st March	Number of towns and villages
1966	3,623
1967	3,673
1968	3,965
1969	4,532
1970*	5,712

*Data Provisional

Source : The Punjab State Electricity Board.

The utilization of electricity for agricultural purposes in the State was studied by examining the annual consumption of electricity per head in the Punjab for irrigation purposes in Table 2.7.

TABLE 2.7

Annual consumption per head of electricity for irrigation in the Punjab 1964-65 through 1968-69

Year	Consumption (k.w.h.)
1964-65	5.21
1965-66	8.82
1966-67	10.67
1967-68	10.86
1968-69	14.58

Source : Central Water and Power Commission.

The annual consumption per head of electricity for irrigation purposes increased from 5.21 k.w.h. in 1964-65 to 14.58 k.w.h. in 1968-69, recording an increase 179.8 per cent during a period of 5 years.

The consumption of electricity for agricultural purposes as a percentage of the total generated in the State is shown in Table 2.8.

TABLE 2.8

Generation and consumption of electricity for agricultural purposes as a percentage of the total generated in the Punjab, 1965-66 to 1968-69

(million k.w.h.)

Year	The total units generated	Units consumed for agricultural purposes	Percentage consumption for agricultural purposes
1965-66	1,818.79	N.A.	N.A.
1966-67	2,015.32	N.A.	N.A.
1967-68	2,227.06	199.18	21.61
1968-69*	2,446.00	366.86	33.22

*Figures for 1968-69 are provisional.

Source : Central Water and Power Commission.

The total number of units of electricity generated in the State increased from 1,818.79 million k.w.h. in 1965-66 to 2,446.00 million k.w.h. in 1968-69. This accounts for 34.4 per cent increase in the electricity generated in the State during a period of 4 years.

The consumption of electricity for agricultural proposes also increased from 119.18 million k.w.h. in 1967-68 to 366.86 million k.w.h. in 1968-69. This increase works out to 208 per cent in 1968-69 over 1967-68. It is hoped that in future, the use of electricity would be further extended to such enterprises as poultry and livestock-breeding and fruit- and vegetable-processing. Research studies have indicated that electric lights in the poultry-house increases egg production by 10 per cent during autumn and winter. Electricity could be used during severe winter to maintain a temperature range of 50°-75°F for promoting plant growth. The Punjab State Electricity Board has estimated that 1.5 million horsepower of additional electric energy will have to be made available to the agricultural sector for irrigation alone by 1980.

Farm Machinery

The different types of power machinery used in the Punjab in 1969 is given in Table 2.9.

TABLE 2.9

Power machinery in use in the Punjab, 1969*

S. No.	Item	No. in use
1.	Disc ploughs ..	2,000
2.	Mouldboard ploughs ..	500
3.	Disc harrows ..	5,000
4.	Cultivators ..	12,000
5.	Blade terracers ..	5,000
6.	Hydraulic levellers or land planes ..	50
7.	Seed-drills ..	1,500
8.	Planters (seed and potato)	130
9.	Plant-protection equipment ..	750
10.	Reapers and binders	40
11.	Groundnut-harvesters ..	50
12.	Threshers ..	80,000
13.	Transport-trailers ..	10,000
14.	Tractors ..	13,000
15.	Pumping-sets ..	80,000

**Source* : Pathak, B.S. 1970. Some problems of mechanisation of agriculture in Punjab. Punjab Agricultural University, Ludhiana.

The harvesting equipment, such as tractor reapers and binders, combines, groundnut-harvesters and potato-harvesters, is gradually becoming popular with the farmers. These machines have great potentials because of their economic advantage over the existing equipment. For example, the studies undertaken by Kahlon and Singh[1] have shown that the cost of harvesting wheat per hectare with a tractor-mounted reaper saves Rs. 81.99 per hectare as compared with the manual harvesting of this crop. The harvesting, threshing and winnowing of wheat per hectare by self-propelled MF 39-6 harvest combine results in a net gain of Rs 108.96 per hectare over the harvesting of the crop with manual labour and threshing and winnowing with a threshing machine. Again, the experiments conducted by the research, testing and training centre in improved agricultural implements in the Punjab State[2] have indicated that the cost per hectare of harvesting potatoes with manual labour works out to Rs 207.50, as against Rs 147.50 with a bullock-drawn potato plough, Rs 130.45 with a tractor-mounted spinner

1. Kahlon, A.S. and Singh, Karam. 1971. Application of partial-budgeting technique to farm-business problems. Punjab Agric. Univ., Ludhiana.
2. Verma, S.R. 1969-70. Report of the research, testing and training centre in improved agricultural implements in Punjab State. College of Agricultural Engineering, PAU, Ludhiana.

digger and Rs. 119.00 with a tractor-mounted single-row potato-elevator-digger. The data on the operation of the recently developed groundnut-digger-shaker show that it can harvest 6 to 8 acres a day at a cost of Rs 18 per acre, which gives an approximate saving of Rs 12 per acre as compared with hand-digging. These studies have, thus clearly brought out the economic advantages of the recently developed equipment over the existing methods. But because the volume of business with the individuals is generally small, these machines are expected to find their way to the farmers through their co-operatives, *panchayats* or the Agro-Industries Corporation. The last-mentioned has already initiated a scheme to procure a fleet of 65 E-512 self-propelled combines for the simultaneous harvesting, threshing and winnowing of wheat and making them available to the farmers on custom-hire. The Punjab Co-operative Marketing Federation has also entered this field. The recent trends indicate that it would be possible to mechanize Punjab agriculture earlier than expected through such custom-hire services.

It could be concluded that rapid technological developments have taken place in the Punjab recently and the farmers are taking advantage of these developments with keen interest. They are after such technology as promises them immediate economic gains.

The future trends indicate that the research in technological variables would provide the Punjab farmers with higher and more efficient alternative production functions and they will choose those fitting in their resource positions and physical environment. The problems of supplies of technical inputs and the distribution of the increased output might multiply and even new related problems might emerg sooner than expected. The State Government and the Punjab Agricultural University have to keep themselves abreast of such problems to furnish suitable solutions.

Chapter III

CHANGES IN THE LAND-USE PATTERN

Land endowment is a major natural resource of a country. On its use, intensive and extensive, depends the distributional pattern of industrial as well as agricultural production. A well-planned utilization of land resources leads to the maximization of the national output. Irrational and injudicious use of it results not only in its own wastage but it also lowers the efficiency of other factors, such as labour and capital operating on it. With the pressure of increasing population, the man-land ratio is increasing fast in the Punjab. In 1951, it was man:land::2.21:1, whereas it increased to 2.67:1 in 1961. Also, the emerging and expanding industrial and urban centres are occupying more space out of the agriculturally productive lands. Land-reclamation efforts, on the other hand, are bringing under the plough culturable wastelands in the country. Again, technological developments and newer cropping patterns are recommended for an intensive utilization of the cultivated land, which reduce the acreage under old and current fallows. All these factors cause discernible changes in the land use and cropping patterns in the State. For effective planning, it is desirable to analyse the existing pattern of land use and also the changes that have come about through time. This section deals with (i) the distribution of land, according to various uses, and (ii) the change in growth rate, indicating shifts in the land-use pattern in the State.

The data on land-use classification and acreages under different crops were obtained from Statistical Abstracts of the Punjab for the period 1950-51 through 1969-70. Compound growth rates were worked out to examine the rate of change in each category and also to study the trend these categories were developing.

Of the 5,038 thousand hectares of geographical area, 4,027 thousand hectares is cultivated in the State. This comprises 79.9 per cent of total geographical area. The latest figures show that total cropped area in the State has gone up to 5,525 thousand hectares in 1969-70 from 4,732 thousand hectares in 1960-61 which contains the 1,498 thousand hectares of area sown more than once in 1969-70. The fallow land has decreased much in the State. It was 148 thousand hectares

in 1969-70 as compared with 313 thousand hectares in 1960-61. The area under forest has gone up from 35 thousand hectares in 1950-51 to 110 thousand hectares in 1969-70. There has been a tremendous change in the land-use pattern in the State during this period. Table 3.1 indicates the percentage growth rates under different land categories in the State during 1960-61 through 1969-70.

TABLE 3.1

The percentage growth-rate of different land-use categories in the State

Land utilization	Growth-rate percentage	SE (value)	't' value
Land under forests ..	15.5	0.79	19.62**
Not available for cultivation ..	—0.83	0.28	2.96*
Other un-cultivated land, excluding fallow land	—8.17	1.91	4.28**
Current fallows ..	—5.81	1.99	2.92*
Net area sown ..	1.72	0.71	2.42*
Area sown more than once ..	5.05	1.75	2.88*
Total cropped area ..	1.90	0.68	2.79*

The land under forests has shown the highest growth-rate during the period 1960-61 through 1969-70. It was 15.5 per cent and was significant at 1 per cent level. Land not available for cultivation has shown a significant decline. Other uncultivated land, excluding fallow land also declined significantly at the compound rate of 8.17. The current fallow also declined at the rate of 5.81 per cent which was significant at 5 per cent. The decline in these categories of land classification resulted in an increase in the net area sown in the State which moved up at the rate of 1.72 per cent, being significant at 5 per cent. Area sown more than once has also increased significantly at the rate of 5.05 per cent, resulting in an increase in the total cropped area.

The analysis of land-use categories was further extended to districts in the State and is presented in Table 3.2.

Area Under Forests

So far as the area under forests is concerned, the Bhatinda District experienced a growth-rate of 36.12 per cent which was highly

TABLE 3.2

Percentage growth-rate of different land-use categories in different districts of the Punjab, 1960-61 through 1969-70

District	Area under forests	Land not available for cultivation	Culturable waste land	Fallow land	Net area sown	Area sown more than once	Total cropped area
Gurdaspur ..	3.32*	—1.30**	..	..	2.50**	5.90*	3.15*
Amritsar ..	..	—1.69	—6.72*	—5.00	1.30	4.20	2.20
Kapurthala ..	..	1.32	..	—3.00*	2.10*	4.02	2.28
Jullundur ..	..	—2.72	..	—2.50	0.70	4.57	2.10
Hoshiarpur ..	7.92	—0.46	—1.98*	—9.11*	0.70	4.00*	1.50**
Ropar ..	9.87	—8.17**	—9.84	—16.44	1.31	6.43	2.80
Ludhiana ..	22.22	0.50	—6.03*	—21.66**	0.60	9.95**	2.80*
Ferozepore ..	..	—0.46	—5.59*	0.22	0.10	7.20**	1.40*
Bhatinda ..	36.12*	2.91*	—13.50*	—34.99**	0.30	5.25*	1.31
Sangrur ..	..	1.52	..	—9.43**	2.20	1.42	0.60
Patiala ..	5.72	1.32	..	2.10	—0.01	1.45	0.20
State ..	15.50**	—0.83*	—8.83**	—5.81*	1.72	5.05*	1.90*

significant. This was followed by Gurdaspur where, although the rate of growth was only 3.32 per cent, yet it was significant. In some other districts—Ludhiana (22.22 per cent), Ropar (9.87 per cent), Hoshiarpur (7.92 per cent) and Patiala (5.72 per cent)—the growth-rates were not significant as the standard errors of growth were very high. The remaining districts did not have much area under forests, hence they were not analysed.

Land not Available for Cultivation

With respect to the land not available for cultivation, six districts of the State, i.e. Gurdaspur, Amritsar, Jullundur, Hoshiarpur, Ropar and Ferozepore, showed a decline. This decline was significant in the case of only two districts, namely Gurdaspur and Ropar. Other districts of the State recorded a positive growth-rate during this period. In Bhatinda, the increase in the 'land not available for cultivation', was significant with a growth-rate of 2.91 per cent. But for the State as a whole, there was a significant decline in 'land not available for cultivation'.

Culturable Waste Land

The culturable waste land declined at the rate of 8.83 per cent in the State. This decline was more pronounced in the Bhatinda District, where it was 13.50 percent, followed by Amritsar (6.72 per cent), Ropar (9.84 per cent), Ludhiana (6.03 per cent), Ferozepore (5.59 per cent) and Hoshiarpur (1.98 per cent). Except in the District of Ropar, the decline was significant in all other districts.

Fallow Land

Owing to the drive for intensive cultivation, the fallow land in the Punjab State declined significantly at the rate of 5.81 per cent. Eight districts in the State recorded a decline in this category of land utilization, namely Jullundur, Hoshiarpur, Ropar, Ludhiana, Bhatinda, Sangrur, Amritsar and Kapurthala. The rate of decline was significant in all the districts, except Jullundur and Amritsar. It was the highest in Bhatinda (34.99 per cent), followed by Ludhiana (21.66 per cent), Ropar (16.44 per cent), Sangrur (9.43 per cent), Hoshiarpur (9.11 per cent), Amritsar (5 per cent) and Kapurthala (3 per cent). The districts of Ferozepore and Patiala recorded a positive growth-rate, but the growth was non-significant. In the Patiala District, the fallow land did not show a decline. This happened, because some parts in the district were affected with water-logging.

Also, a large portion of the land in these districts, where the growth-rate was positive, was unirrigated, with the result that the intensity of cropping could not be increased consistently.

Net Area Sown

The net area in the State increased significantly at the rate of 1.72 per cent. The net area sown in the districts of Gurdaspur and Kapurthala increased significantly during 1960-61 through 1969-70. In all other districts of the State, except Patiala, the net area sown increased but not significantly. Gurdaspur had a growth-rate of (2.50 per cent), Kapurthala (2.10 per cent), Amritsar (1.30 per cent), Jullundur and Hoshiarpur (0.70 per cent), Ropar (1.31 per cent), Ludhiana (0.60 per cent), Ferozepur (0.10 per cent), Bhatinda (0.30 per cent) and Sangrur (2.20 per cent). But in Patiala, the net area sown experienced a decline at the rate of 0.01 per cent.

Area Sown more than Once

As a result of intensive cultivation measures, it is encouraging to note that the area under double- or multiple-cropping increased at a significant rate of 5.05 per cent in the State. In the districts of Gurdaspur, Hoshiarpur, Ropar, Ludhiana, Ferozepore and Bhatinda, the growth with respect to this category of land use was significant. Highest significant growth-rate was recorded in Ludhiana (9.95 per cent), followed by Ferozepore (7.20 per cent), Ropar (6.43 per cent), Gurdaspur (6.90 per cent), Bhatinda (5.25 per cent) and Hoshiarpur (4 per cent). In the remaining districts, the growth was positive, but was non-significant.

Total Cropped Area

As a result of the shifts in land acreage from the culturable waste land and fallow lands to cultivated lands and also because of intensive cultivation, the total cropped area in the State increased significantly at the rate of 1.90 per cent. The total cropped area increased significantly in Gurdaspur (3.15 per cent), in Ludhiana (2.80 per cent), in Hoshiarpur (1.50 per cent) and in Ferozepore (1.40 per cent). In the remaining districts, the increase was non-significant.

Intensity of Cropping

Whereas through the lapse of time there occurred shifts in the land-use patterns between the major categories of land

utilization, there also came about changes in the cropping intensity on the cultivated lands in the State as under :

Year	*Intensity*
1960-61	125.95
1961-62	125.45
1962-63	129.71
1963-64	126.46
1964-65	131.27
1965-66	128.50
1966-67	133.62
1967-68	136.30
1968-69	134.18
1969-70	137.13

Growth rate : +0.9887 per cent

The intensity of cropping in the State has increased significantly at 0.9887 per cent rate of growth. As against 25.95 per cent of land being double-cropped in 1960-61, it was 37.13 per cent in 1969-70.

The change in the crop intensity in different districts is shown in Table 3.3.

In the Gurdaspur District, the crop intensity rose from 135.2 in 1960-61 to 149.2 in 1969-70, with growth-rate of 1.32 per cent which was significant at the 5 per cent probability level. The Amritsar District showed a rise in crop intensity at the level of 158.1 in 1966-67, as against 137.3 in 1960-61 but it started declining from 1966-67 onwards and came down to 147.3 in 1969-70. The growth-rate was quite low, i.e. 0.82 per cent, but it was significant. The highest significant growth-rate was noted in the Ludhiana District. It was 2.30 per cent and was significant at the one per cent probability level, followed by Ropar (1.58 per cent), Jullundur (1.45 per cent), Ferozepore (1.26 per cent), Kapurthala (1.03 per cent), Bhatinda (0.96 per cent) and Hoshiarpur (0.85 per cent). In Sangrur and Patiala, the rate of growth of the crop intensity was not significant statistically and was as low as 0.29 and 0.19 per cent respectively.

Changes in Cropping Patterns

In addition to the shifts in major land-use categories and in the intensity of cropping, there occurred quite significant changes in cropping pattern of the State. The analysis was carried to the district level and the growth-rates of area under different

TABLE 3.3

Crop intensity in different districts of the Punjab, 1960-61 to 1969-70

Year	Gurdas-pur	Amritsar	Kapur-thala	Jullundur	Hoshiar-pur	Ropar	Ludhi-ana	Feroze-pore	Bhatinda	Sangrur	Patiala
1960-61	135.2	137.3	113.4	122.4	129.6	126.5	125.8	116.1	117.7	137.2	136.3
1961-62	132.8	139.2	114.0	120.8	126.9	134.2	124.7	119.1	119.7	136.6	122.1
1962-63	107.5	152.3	131.8	126.9	133.5	132.5	127.3	118.7	121.3	139.9	128.8
1963-64	139.2	146.1	128.2	122.3	134.8	128.0	130.4	119.4	114.5	131.0	124.4
1964-65	140.5	155.4	131.4	134.7	137.1	133.9	139.5	121.2	122.5	134.5	127.7
1965-66	130.7	146.3	126.4	130.2	137.3	130.0	137.8	118.5	116.2	128.3	140.8
1966-67	139.7	158.1	121.4	140.9	141.7	122.2	141.1	129.6	117.2	129.7	141.6
1967-68	138.0	156.2	122.3	134.6	139.3	147.6	143.3	131.0	128.6	139.3	132.8
1968-69	136.3	151.6	121.1	133.9	137.6	148.7	149.0	128.6	122.7	138.5	126.4
1969-70	149.2	147.3	118.3	136.9	136.9	148.3	153.5	127.3	132.4	144.4	130.1
Percentage growth-rate	1.32	0.82	1.03	1.45	0.85	1.58	2.34	1.26	0.96	0.29	0.19

C.F.T.R.I. Library Information Unit. LUCKNOW
No. 3 (c) 1981
1985

TABLE 3.4

Percentage growth-rate of area under different crops in different districts of the Punjab, 1961

District	Maize	Wheat	Rice	*Bajra*	Gram	Groundnut	Sugarcane	Cotton *desi*	Cotton American
Kapurthala	4.6**	2.82	3.38**	..	—8.89	..	—2.18**	..	..
Amritsar	3.7**	2.14**	6.68**	—3.38**	—5. .*	..	1.12	1.02**	1.83
Gurdaspur	2.1**	0.14	5.15**	—5.14**	— .14**	..	5.30**	..	..
Sangrur	4.2**	4.01**	8.67**	11.30**	..	21.70**	1.16**	0.05	—2.76
Ferozepore	8.3**	2.47**	10.64	—0.74	—0.67	..	6.30**	5.95**	2.21**
Patiala	1.02**	4.06**	10.49**	..	1.64	8.19**	4.86**	1.23	5.66**
Hoshiarpur	2.6	—0.28	3.38**	—5.87**	—3.68**	..	0.67	—12.57*	..
Jullundur	0.76	2.69**	2.34**	—13.16**	—6.26**	13.87**	1.71**	3.42**	—3.32
Ludhiana	5.93**	4.49**	..	—4.19*	—8.74**	7.15**	2.90**	3.82*	0.46
Bhatinda	..	4.97*	..	1.94*	—1.32	..	10.51**	0.53	7.85**
State	4.01**	2.99**	6.39**	—0.03	—3.06**	9.58**	2.62**	2.78**	2.62

crops were worked out. These growth-rates are presented in Table 3.4. In the State as a whole, the area under maize, wheat, rice, groundnut, sugarcane and cotton (*desi*) increased significantly at the rates of 4.01, 2.99, 6.39, 9.58, 2.62 and 2.78 per cent respectively. The area under *bajra* declined at the rate of 0.3 per cent which was non-significant. The area under gram decreased significantly. The area under American cotton did not show any significant increase.

The district-wise growth of area under different crops is discussed in the following section :

Maize: The area under the maize crop increased significantly in almost all the districts in the Punjab State except in Hoshiarpur and Jullundur. The rate of growth in the area under maize in Kapurthala was 4.6 per cent, in Amritsar 3.7 per cent, in Gurdaspur 2.1 per cent, in Sangrur 4.2 per cent, in Ferozepore 8.3 per cent, in Patiala 1.02 per cent, and in Ludhiana 5.93 per cent, as against 4.01 per cent for State as a whole.

Wheat : Owing to its profitability compared with other competing crops, the area under wheat expanded significantly in the State, except in Kapurthala, Gurdaspur and Hoshiarpur districts. The percentage rate of growth of the area under this crop was 2.14 in Amritsar, 4.01 in Sangrur, 2.47 in Ferozepore, 4.06 in Patiala, 2.69 in Jullundur, 4.49 in Ludhiana and 4.97 in Bhatinda, as against 2.99 in the State as a whole.

Rice : Of the rice-growing districts in the State, the area under rice increased significantly in all the districts except Ferozepore. The rate of growth of the area under rice was 3.38 per cent in Kapurthala, 6.68 per cent in Amritsar, 5.15 per cent in Gurdaspur, 8.67 per cent in Sangrur, 10.49 per cent in Patiala and 3.38 per cent in Hoshiarpur. The growth-rate for the State as a whole was 6.39 per cent which was highly significant. The Punjab is mainly a wheat-producing and wheat-consuming State. The new varieties of paddy have raised the hopes of rice-growers in the State. The trend is healthy and the area might continue to grow significantly in the future.

Bajra : The area under *bajra* has shown a significant decline in Amritsar, Hoshiarpur, Gurdaspur, Jullundur and Ludhiana. It increased significantly in Sangrur and Bhatinda which are the districts favourable for the growth of *bajra*. This shows that the growth of area in these districts *vis-a-vis* the decline in area under other districts is a favourable shift in acreage.

Groundnut : The area under groundnut increased in the State at the rate of 9.58 per cent which was significant at one per cent level. It increased significantly in Sangrur, Patiala, Jullundur and Ludhiana. Sangrur recorded the highest growth-rate, i.e. 21.70 per cent, followed by Jullundur (13.87 per cent), Patiala (8.19 per cent) and Ludhiana (7.15 per cent).

Gram : The area under gram decreased significantly in the State at the compound rate of 3.06 per cent. It decreased significantly in Kapurthala (8.89 per cent), Amritsar (5.64 per cent), Gurdaspur (4.14 per cent), Hoshiarpur (3.68 per cent), Jullundur (6.26 per cent) and Ludhiana (8.74 per cent). In the districts of Bhatinda and Ferozepore, the decline was not significant. The Patiala District showed an increase in the area under gram, but it was non-significant.

Sugarcane : The sugarcane area in the State increased significantly at the rate of 2.62 per cent. The area under this crop increased significantly in all the districts, except in Amritsar and Hoshiarpur. The highest growth-rate in the area under sugarcane was recorded in the Bhatinda District (10.51 per cent). It was 6.30 per cent in Ferozepore, 5.30 per cent in Gurdaspur, 4.86 per cent in Patiala, 2.90 per cent in Ludhiana, 2.18 per cent in Kapurthala, 1.71 per cent in Jullundur and 1.16 per cent in Sangrur.

Cotton (*desi*) : The area under *desi* cotton increased significantly in the State at the rate of 2.78 per cent. Amritsar, Ferozepore, Jullundur and Ludhiana recorded significant growth with respect to the area under *desi* cotton. The highest growth was recorded in the Ferozepore District (5.95 per cent) followed by Ludhiana (3.83 per cent), Jullundur (3.42 per cent) and Amritsar (1.02 per cent). The area under *desi* cotton increased in Sangrur, Bhatinda and Patiala at the rates of 0.05, 0.53 and 1.23 per cent respectively, but these increases were not significant statistically. The area under *desi* cotton declined significantly in the Hoshiarpur District.

Cotton (American) : The area under this crop increased significantly in the districts of Bhatinda, Patiala and Ferozepore. The Bhatinda District recorded the highest growth rate of 7.85 per cent, followed by Patiala (5.66 per cent) and Ferozepore (2.21 per cent). Other districts, namely Amritsar and Ludhiana, recorded an increase in the area, but the rate of growth was non-significant in these districts. The area under this crop recorded a decline in the districts of Sangrur and Jullundur, but this decline was non-significant statistically.

Chapter IV

AGRICULTURAL GROWTH-RATES

It is pertinent to examine critically the rate of growth in agricultural production and productivity in the Punjab to serve as a basis for future policy decisions. An attempt is made here to measure the increase in production during the period 1950-51 through 1969-70. The total production being a function of productivity per unit area, the area under different crops, and changes in the cropping pattern, it is considered appropriate to assess the growth and the relative contribution of these variables to total production during this period. The productivity per acre has been changing all the time. Whereas some districts have shown relatively better growth than the average at State level, there are others which have not kept pace even with the State level. This aspect has also been studied separately in this chapter.

The data used here on the production, productivity (yield) and acreage of important crops were obtained from *Statistical Abstracts* of the State published by the Punjab Government. For the purpose of studying the growth rates of production and productivity of different crops, the data pertains to the period 1950-51 through 1969-70. The relative contribution of different components of production to the total production, refers to the recent decade, i.e. 1960-61 through 1969-70. The growth-rates for production and productivity were worked out by making use of an exponential function. An additive model[1] was used to study the relative contribution of different factors, viz. yield, area and cropping pattern.

Table 4.1 shows that the rate of growth in production with respect to crops studied, i.e. maize, rice, groundnut, sugarcane, *desi* cotton and American cotton, were highly significant statistically. The highest growth-rate was recorded in groundnut production in the State, i.e. 13.74 per cent. It was followed by rice (8.87 per cent), sugarcane (6.68 per cent), maize (7.33 per cent), wheat (6.81 per cent), *desi* cotton (6.13 per cent), and American cotton (4.76 per cent). Gram showed a negative growth-rate which was significant at 5 per cent probability level. *Bajra* production showed a significant decline. The decline can be attributed to the extension of irrigational facilities in the dry

1. Minhas, B.S. and Vaidyanathan, A. 1965. Growth of crop output in India, 1951-54 to 1958-61—An analysis by component elements. *J. Indian Soc. Agric. Stat.* **27**(2): 230-52.

areas of the Punjab, which resulted in a changed cropping pattern of the areas.

TABLE 4.1

Growth-rates of production and productivity with respect to selected crops in the Punjab, 1950-51 through 1969-70

Crops	Production	Yield
Maize ..	7.33**	3.99**
Wheat ..	6.81**	4.88**
Rice ..	8.87	1.71
Bajra ..	—2.67*	3.02**
Gram ..	—2.84*	0.20
Groundnut ..	13.74**	2.57**
Sugarcane ..	6.68**	1.30**
Cotton (*desi*) ..	6.13**	8.12**
Cotton (American) ..	4.76**	2.57**

The rate of growth of yield was significant in all the crops under study, except rice and gram. A high growth-rate was recorded in the case of *desi* cotton at 8.12 per cent. It was followed by wheat (4.88 per cent), maize (3.99 per cent), *bajra* (3.02 per cent), groundnut (2.57 per cent) and American cotton (2.57 per cent). The rice yield did not increase significantly in the State. The growth-rate of yield in the case of gram did not come out to be significant.

The growth-rate of yield and production of different crops was also worked out for the districts of the Punjab. The results are presented in Tables 4.2 and 4.3.

Production

Maize : The production of maize in the State increased significantly. Production also increased significantly in the districts of Kapurthala, Amritsar, Gurdaspur, Ferozepore, Patiala, Hoshiarpur, Jullundur and Ludhiana. It was non-significant in the Sangrur District. The highest growth-rate was experienced by Ludhiana at 10.15 per cent. It was followed by Jullundur (8.5 per cent), Ferozepore (8.4 per cent), Hoshiarpur (5.2 per cent). Amritsar (4.6 per cent), Kapurthala (3.9 per cent) and Patiala

TABLE 4.2

Compound growth-rates of production of different crops in the Punjab, 1950-51 through 1969-70

Districts	Maize	Wheat	Rice	*Bajra*	Gram	Groundnut	Sugarcane	Cotton (*desi*)	Cotton (American)
Kapurthala	3.9**	6.00**	13.11*	..	—10.79**	..	—0.39	..	..
Amritsar	4.6**	0.63	5.37**	0.40	—4.50**	..	3.47**	1.32**	2.23
Gurdaspur	4.1*	5.66**	4.11**	—1.53	—1.23	..	4.61**	..	..
Sangrur	5.0	6.93**	11.05**	0.74	..	22.91**	3.49*	1.14	—3.75
Ferozepore	8.4**	5.74**	2.82	1.39	—4.52**	..	7.48**	2.18*	4.78**
Patiala	2.6**	9.07**	15.72**	..	2.80	14.53**	3.72**	0.37	—1.30
Hoshiarpur	5.2**	2.28	2.69*	—14.98**	—8.13**	..	1.67	—5.44**	..
Jullundur	8.5**	6.39**	12.23**	..	—5.42**	16.27**	1.91**	2.71*	..
Ludhiana	10.15**	10.20**	..	..	—8.04**	9.32**	..	6.86**	2.57
Bhatinda	..	9.34**	..	..	—0.62	..	10.25**	9.80	11.94*
State	7.33*	6.81**	8.87**	—2.67*	—2.84*	13.74**	6.68**	6.13**	4.76**

(2.6 per cent). Although the rate of growth of maize production was as high as 4.1 per cent, yet it was non-significant because of greater fluctuation in production during the period.

Wheat : Wheat production increased in the State at the rate of 8.61 per cent which was highly significant. Of the districts growing wheat, Ludhiana experienced the highest growth-rate of 10.20 per cent, followed by Patiala (9.07 per cent), Bhatinda (9.34 per cent), Sangrur (6.93 per cent), Jullundur (6.90 per cent), Kapurthala (6.00 per cent), Ferozepore (5.74 per cent), Gurdaspur (5.66 per cent), etc. But the Amritsar and Hoshiarpur districts did not experience any significant rate of growth in the matter of production of wheat.

Rice : The production of rice also showed a significant growth in the State. It was 8.87 per cent during 1950-70. Patiala experienced the highest growth-rate of 15.72 per cent which was significant at 1 per cent probability level. Kapurthala, Sangrur and Jullundur recorded a rate of growth which was higher than the State growth-rate. Amritsar, Gurdaspur, and Hoshiarpur experienced a lower growth-rate than that of the State. The rate of growth of rice production was significant in all these districts, except in Ferozepore where it was 2.82 per cent and was non-significant.

Bajra : The production of *bajra* declined in the State at the compound growth of 2.67 per cent. In the Hoshiarpur District, the rate of decline was 14.98 per cent which was significant at 1 per cent probability level. In the remaining districts, the growth was not statistically significant.

Gram : The production of the gram crop declined significantly in the State during this period. For the districts, namely Kapurthala, Amritsar, Ferozepore, Hoshiarpur, Jullundur and Ludhiana, the growth-rate was negative and significant. But in other districts, such as Gurdaspur and Bhatinda, the decline was non-significant. In the Patiala District, the production of gram increased, but the increase was non-significant. In 1969-70, there was a decline in gram production in the State.

Groundnut : The production of groundnut in the State increased significantly at the rate of 13.74 per cent. Sangrur experienced the highest growth-rate of 22.91 per cent which was significant at 1 per cent probability level. It was followed by Jullundur (16.27 per cent), Patiala (14.53 per cent) and Ludhiana (9.32 per cent). The growth-rate in all these districts worked out to be significant.

Sugarcane : The sugarcane production increased in the State at the compound growth-rate of 6.68 per cent which was significant at 5 per cent level. Bhatinda recorded the highest growth-rate at 10.25 per cent. The only other district which experienced a higher rate of growth than the State as whole, was Ferozepore. Its growth-rate was 7.48 per cent. Other districts where the growth-rates were significant, were Amritsar (3.47 per cent), Gurdaspur (4.61 per cent), Sangrur (3.49 per cent), Patiala (3.72 per cent) and Jullundur (1.91 per cent). Hoshiarpur did not record a significant growth rate. In Kapurthala, the production declined but it was insignificant.

Cotton *desi* : The production of cotton *desi* increased at the rate of 6.13 per cent in the State. This rate of growth was significant at 1 per cent probability level. Ludhiana is the only district which experienced a higher growth-rate than the State in so far as the production of cotton (*desi*) was concerned. It was 6.86 per cent, followed by Jullundur (2.71 per cent), Ferozepore (2.18 per cent), Amritsar (1.32 per cent) and Sangrur (1.14 per cent). The rate of growth was significant in all these districts. However, the district of Bhatinda recorded as high a growth-rate as 9.80 per cent, but it was non-significant owing to great fluctuations in production. Patiala also did not experience a significant growth in so far as the production of cotton (*desi*) was concerned. The production of cotton (*desi*) declined significantly at the rate of 5.44 per cent in Hoshiarpur District.

Cotton American : There was a significant increase in cotton (American) production in the State. It increased at the rate of 4.76 per cent per annum. The districts of Ferozepore and Bhatinda recorded a highly significant growth in the production of American cotton. Bhatinda recorded the highest growth rate, i.e. 11.94 per cent, followed by Ferozepore, where it was 4.78 per cent. Both these districts had a higher growth-rate than the State's average. Other districts producing cotton (American) did not show a significant increase in production. The Sangrur and Patiala districts recorded a decline in production, although the decline was not significant.

Productivity

Production is calculated as a product of productivity and the area under a crop. The increase in production may be due to the increase in productivity, or the increase in acreage under the net crop, or due to increase in both. As such, a separate analysis of growth of productivity of crops is necessary. The results of this type of analysis are presented in Table 4.3.

TABLE 4.3

Growth-rates of productivity of various crops in the Punjab, 1950-51 through 1969-70

Districts	Maize	Wheat	Rice	*Bajra*	Gram	Groundnut	Sugarcane	Cotton (*desi*)	Cotton (American)
Kapurthala	—7.8	3.65**	4.37*	..	—1.07	..	0.26	..	..
Amritsar	0.60	0.42	0.60	1.93	1.23	..	2.23*	1.91	3.86**
Gurdaspur	1.86	3.89**	—0.26	1.12	—1.67	..	1.46	..	..
Sangrur	1.88	3.70**	2.38	2.62	..	3.94**	2.09*	1.69**	0.93
Ferozepore	0.32	22.91*	0.32	1.72	0.67	..	0.28	2.18**	3.35
Patiala	1.71	4.64**	5.50**	..	0.16	5.40	0.93	2.85	1.64
Hoshiarpur	20.86*	2.47**	—0.49	—2.84*	—0.35	..	0.16	0.46	..
Jullundur	0.81	2.30*	0.12	0.32	—0.23	2.11*	20.64**	1.05	..
Ludhiana	3.61**	6.68**	..	2.51**	0.60	2.41**	1.00*	3.56	2.05
Bhatinda	..	6.15**	..	1.65	0.65	..	1.51*	—1.19**	3.96**
State	3.99**	4.88**	1.71	3.02*	0.20	2.57**	1.30*	8.12**	2.57**

Maize : The productivity per hectare of the maize crop increased in the State at the rate of 3.99 per cent which was significant at 1 per cent probability level. Of the districts, where the productivity of the maize crop increased significantly, Hoshiarpur recorded the highest growth-rate of 20.86 per cent, followed by Ludhiana, where it was 3.61 per cent. The districts of Amritsar, Gurdaspur, Sangrur, Ferozepore, Patiala and Jullundur experienced an increase in the yield-rate, but the increase was non-significant. The productivity of the maize crop declined in Kapurthala, but it was non-significant.

Wheat : The productivity of the wheat crop in the State recorded a significant increase. The rate of growth of the yield of this crop in the State was 4.88 per cent which was highly significant at 1 per cent level of probability. With the exception of Amritsar, all other districts in the State experienced a significant growth. The highest growth was recorded in the Ferozepore District. It was 22.91 per cent per annum. This was followed by Ludhiana (6.68 per cent), Bhatinda (6.16 per cent), Patiala (4.64 per cent), Gurdaspur (3.89 per cent), Sangrur (3.70 per cent) and Kapurthala (3.65 per cent). The lowest growth-rate of 2.30 per cent was recorded in the Jullundur District.

Rice : Rice productivity did not increase significantly in the State. It was 1.71 per cent. However, there were districts, like Patiala and Kapurthala, where the growth-rate with respect to the productivity of rice was highly significant. Patiala experienced a growth-rate of 5.50 per cent and it was 4.37 per cent in Kapurthala. Amritsar, Sangrur, Ferozepore and Jullundur showed increases in yield-rate, but the increases were non-significant. The productivity of rice declined in Gurdaspur and Hoshiarpur, but the decline was non-significant.

Bajra : The rate of growth of productivity in respect of the *bajra* crop increased significantly in the State. Hoshiarpur was the only district where a decline was recorded at the rate of 2.84 per cent. In all other districts, the yield was positive but non-significant. Ludhiana showed an increase which was significant at 1 per cent probability level.

Gram : The productivity of the gram crop did not show any significant increase. Although there was an increasing trend in the yield-rate in some of the districts, it did not turn out to be significant.

Groundnut : The productivity of groundnut increased at the rate of 2.57 per cent which was significant at 1 per cent probability level. Except Patiala, all other districts, namely Sangrur, Jullundur and Ludhiana experienced a highly significant rate of growth. It was 3.94 per cent in Sangrur, 2.41 per cent in Ludhiana and 2.11 per cent in Jullundur.

Sugarcane : The sugarcane yield increased significantly in the State. The highest growth-rate was recorded in Jullundur. It was 20.64 per cent, followed by Amritsar (2.23 per cent), Sangrur (2.09 per cent), Bhatinda (1.51 per cent), and Ludhiana (1 per cent). In the remaining districts, the rates of growth did not work out to be significant, although they were positive.

Cotton *desi* : The yield of *desi* cotton increased significantly It was 8.12 per cent which was statistically significant at 1 per cent probability level. Only two districts, i.e. Sangrur and Ferozepore, experienced a growth which was highly significant. Of these, the higher growth was recorded in Ferozepore, i.e. 2.18 per cent. The remaining districts showed positive but statistically non-significant growth. In Bhatinda, the productivity of cotton *desi* declined significantly.

Cotton (American) : Cotton (American) showed a significant increase, in so far as yield per hectare was concerned, in the State. It worked out to be 2.57 per cent. Bhatinda recorded a higher growth-rate than the State averages. It was 3.96 per cent in Bhatinda. In Amritsar, the productivity increased at the rate of 3.86 per cent which was significant.

The trend of area, production and productivity has also been shown graphically in Figs. 3 to 11.

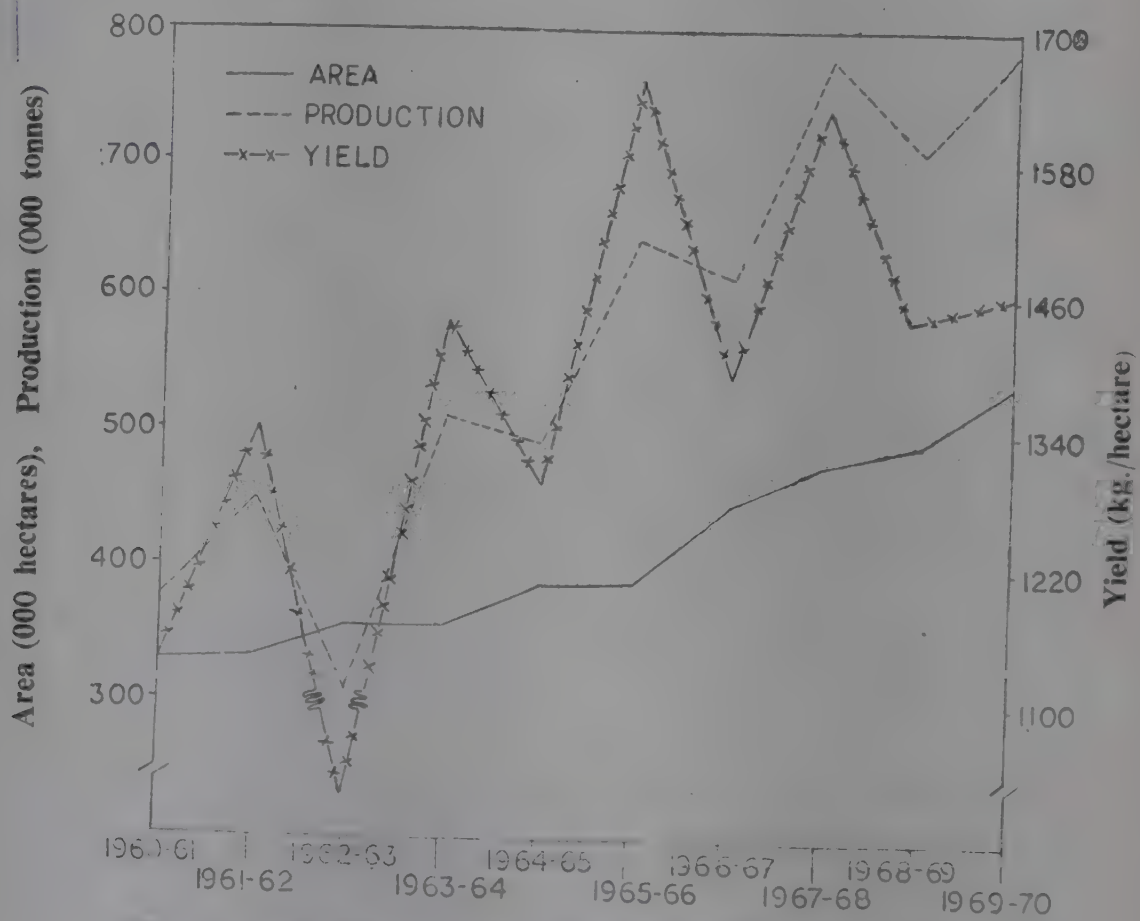


Fig. 3. The trend of area, production and yield of maize in the Punjab, 1960-61 to 1969-70

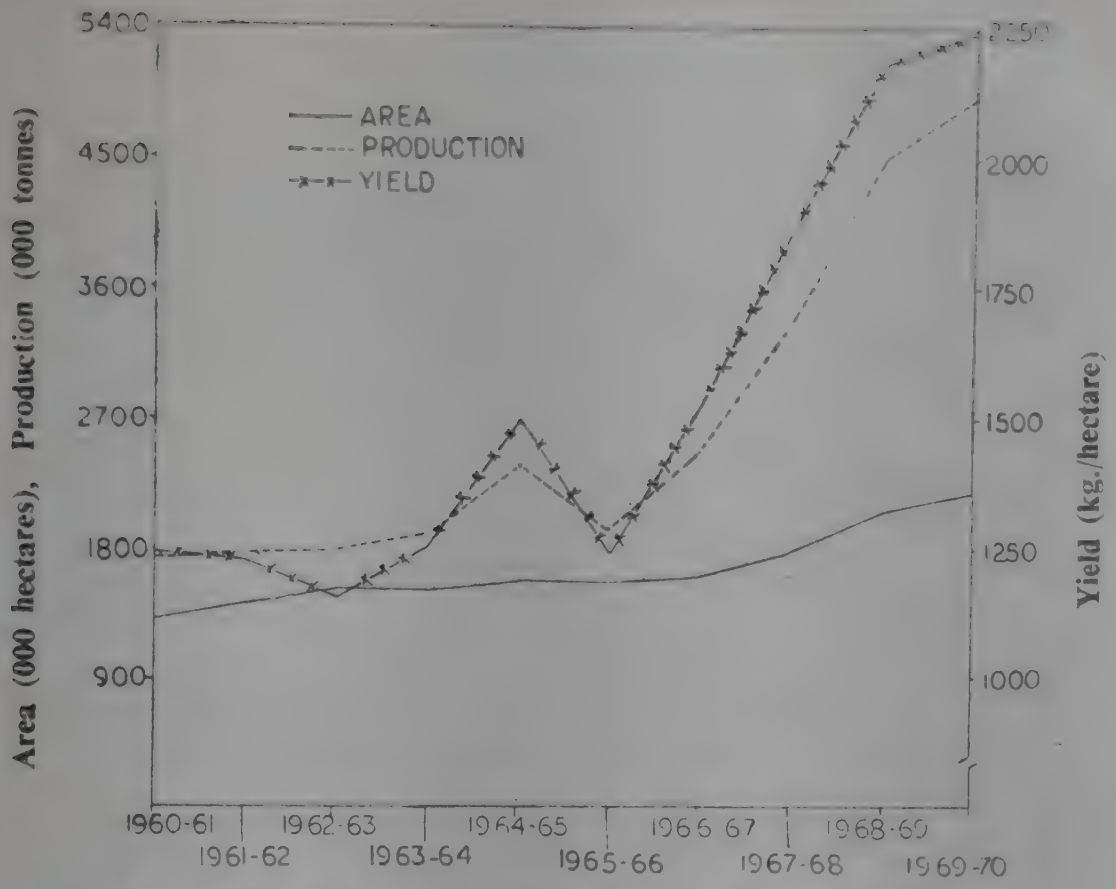


Fig. 4. The trend of area, production and yield of wheat in the Punjab, 1960-61 to 1969-70

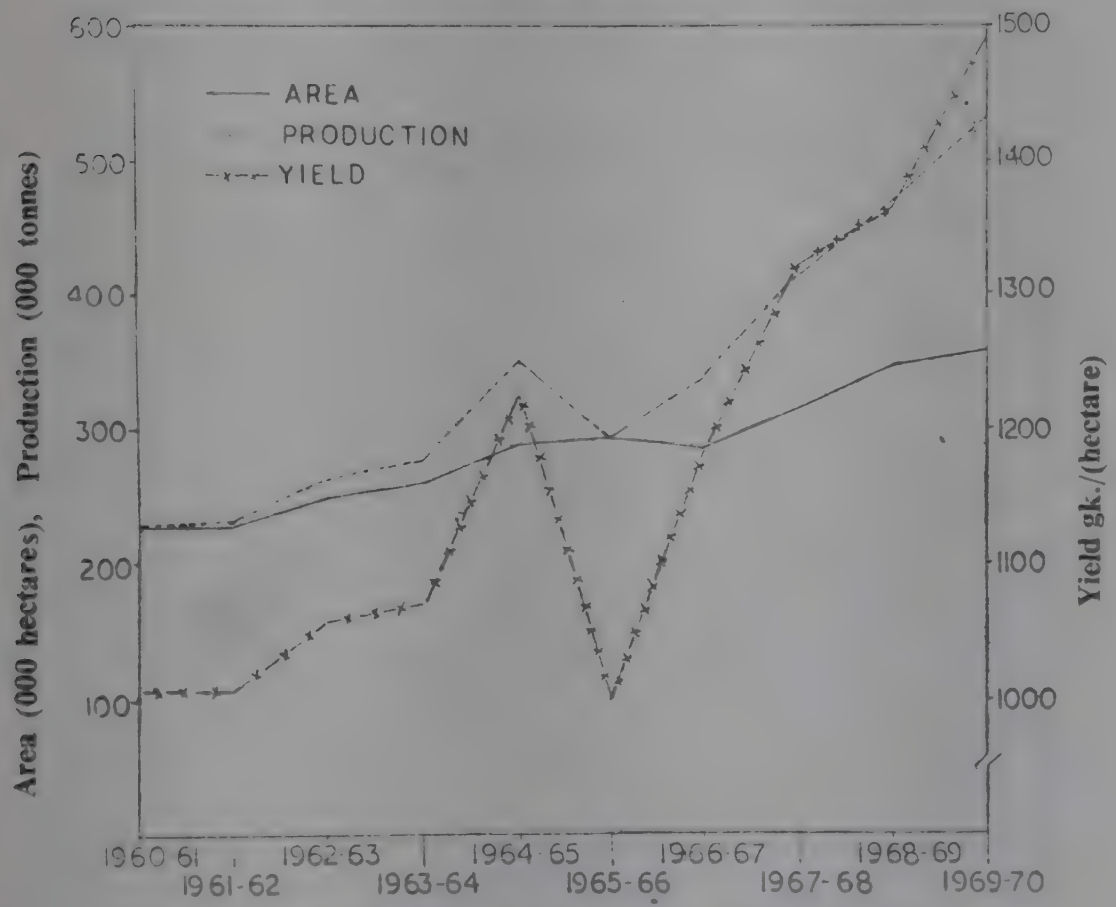


Fig. 5. The trend of area, production and yield of rice in the Punjab, 1960-61 to 1969-70

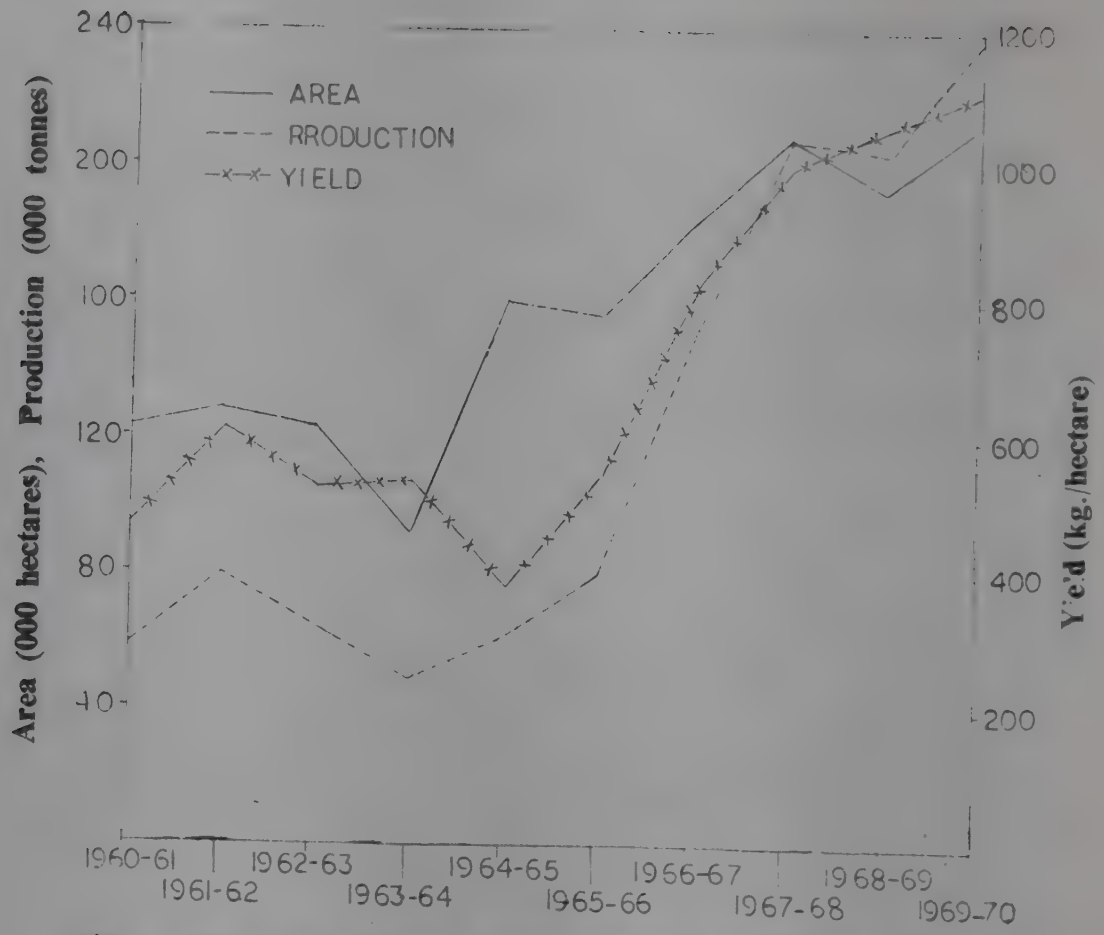


Fig. 6. The trend of area, production and yield of *bajra* in the Punjab, 1960-61 to 1969-70

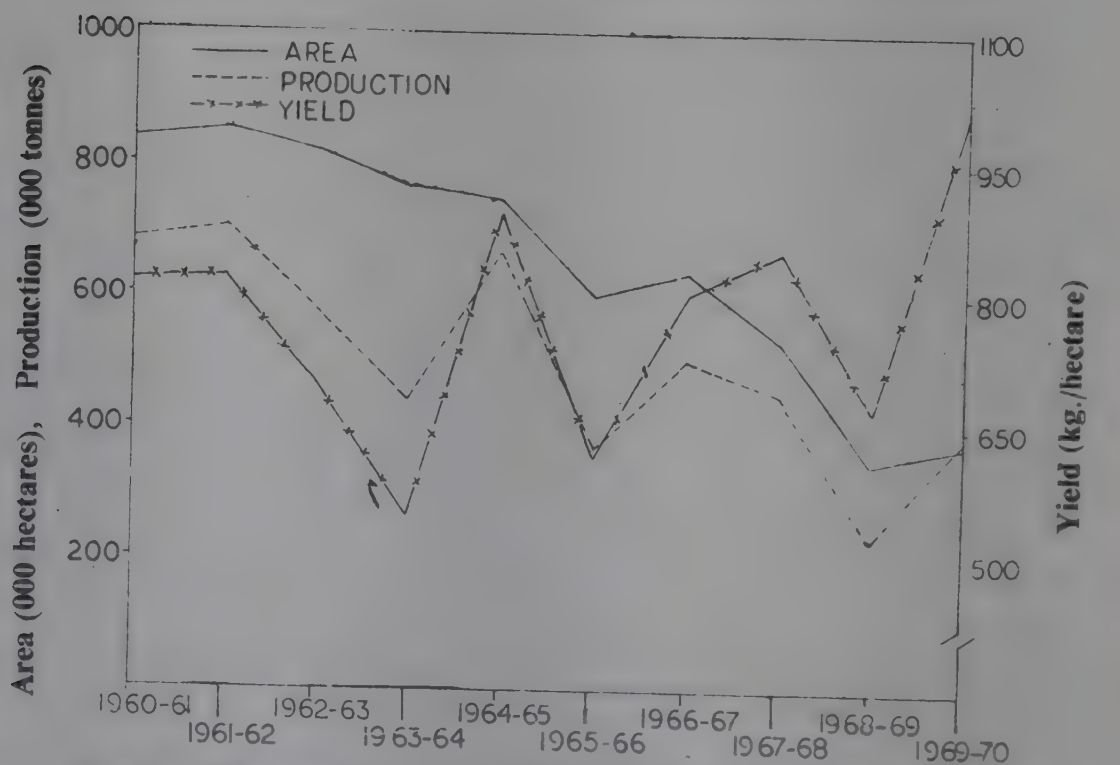


Fig. 7. The trend of area, production and yield of gram in the Punjab, 1960-61 to 1969-70

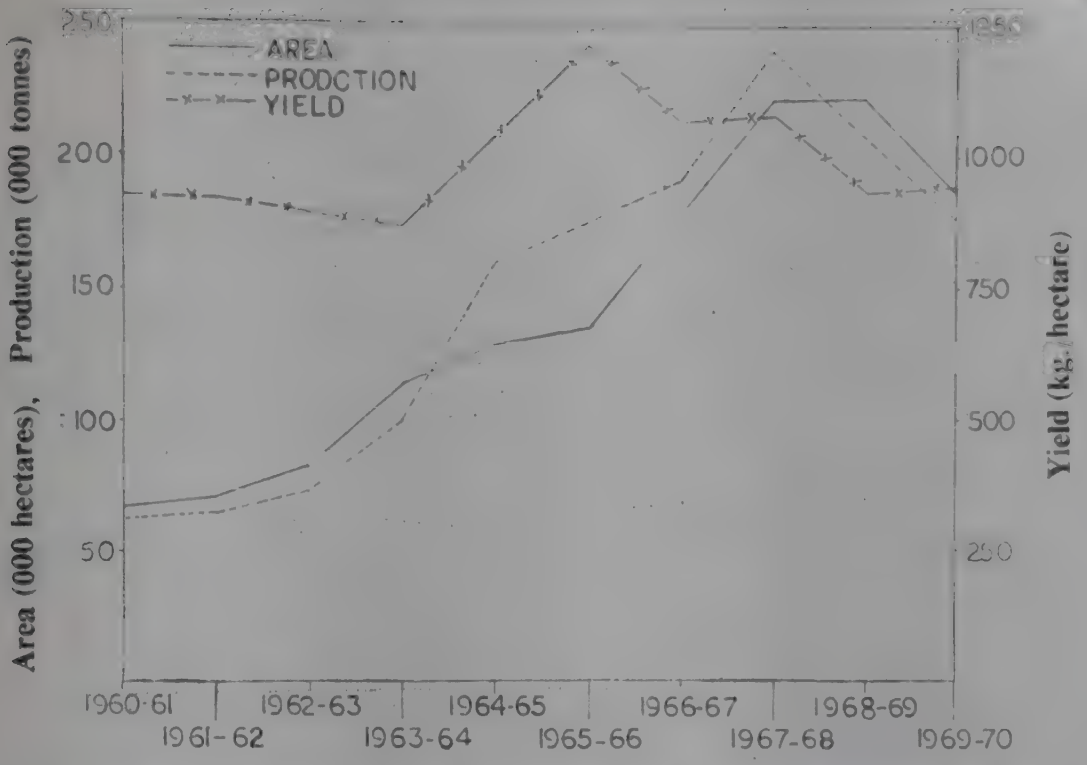


Fig. 8. The trend of area, production and yield of groundnut in the Punjab, 1960-61 to 1969-70

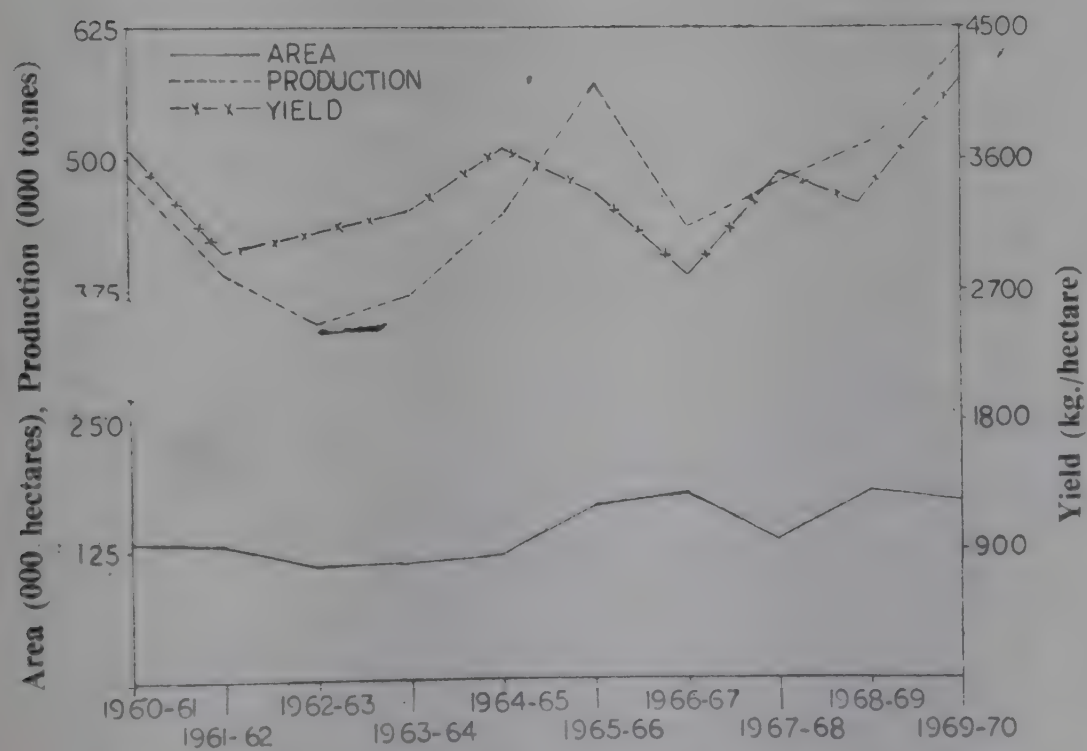


Fig. 9. The trend of area, production and yield of sugarcane in the Punjab, 1960-61 to 1969-70

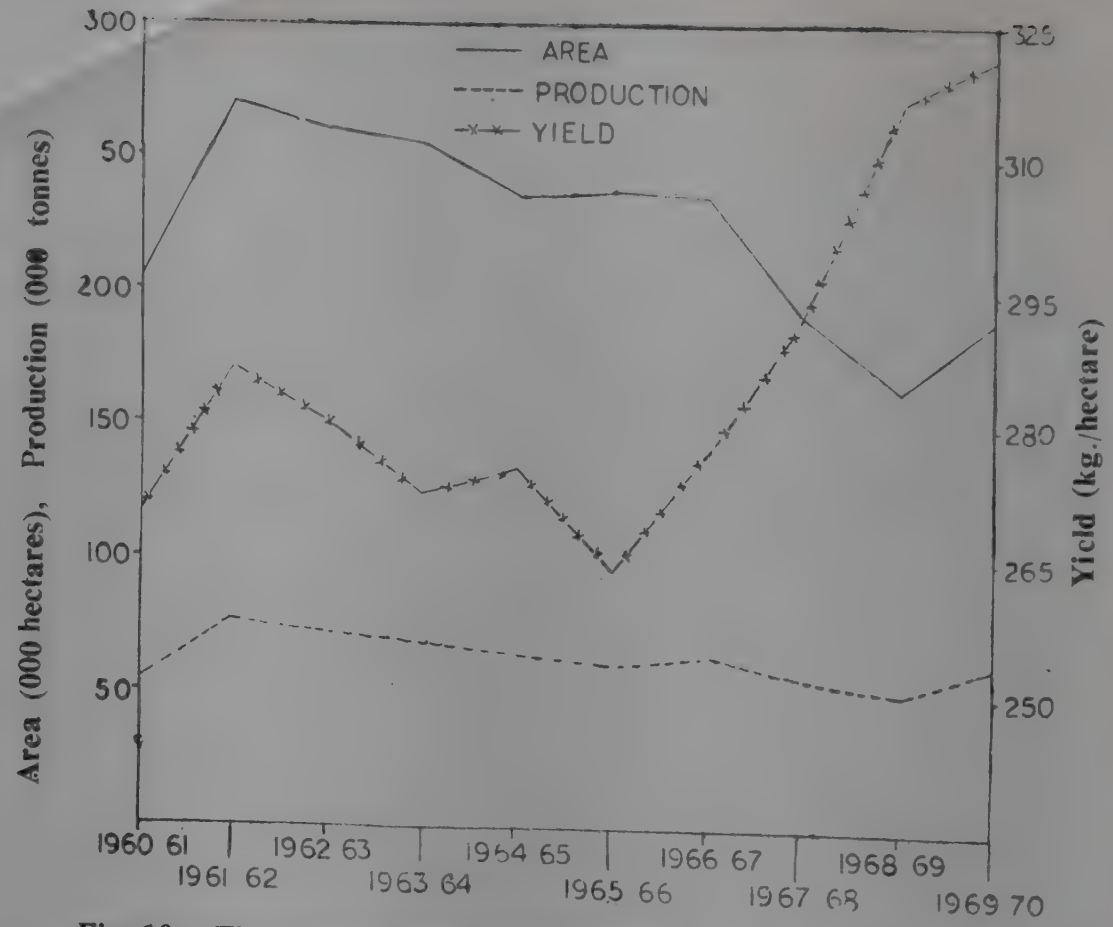


Fig. 10. The trend of area, production and yield of *desi* cotton in the Punjab, 1960-61 to 1969-70

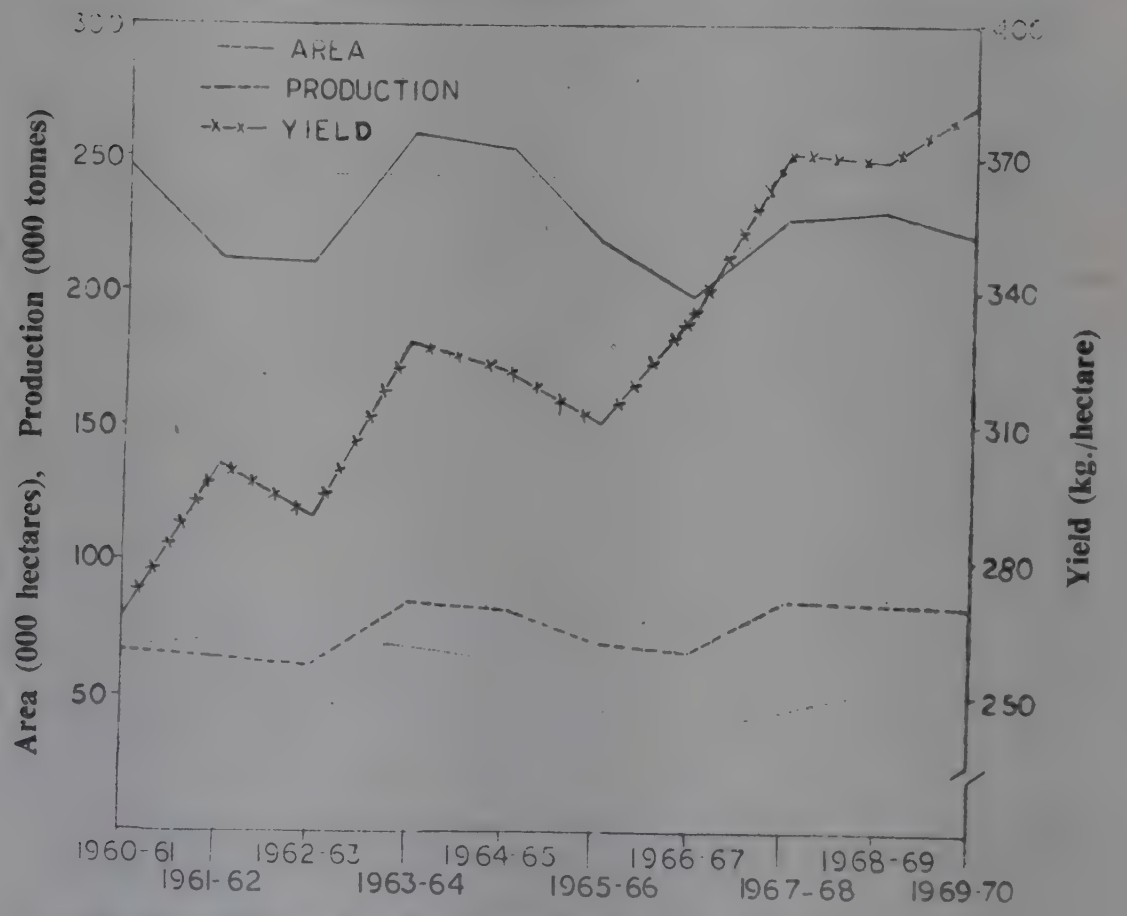


Fig. 11. The trend of area, production and yield of American cotton in the Punjab, 1960-61 to 1969-70

The Relative Contribution of Various Components to the Agricultural Growth

In order to visualize clearly the contribution of different factors, such as the change in yield, the cropping pattern and the acreage to agricultural production of the State, in general, and of the districts, in particular, the data were subjected to an analysis by component elements. The district-wise analysis of agricultural output brought out some of the results recorded earlier. The four-factor additive and the multiplicative model were used to analyse the data. It was found that the results were almost similar. The discussion presented here is based on the four-factor additive model. This analysis was done for the period 1960-61 through 1969-70. This was restricted to this decade only, because the major breakthrough in agricultural technology came during this period.

The changes in the yield were mainly responsible for the change in production in the State of the Punjab as also in all the districts. In the State as a whole, 66.11 per cent of change is attributed to the change in productivity, 15.53 per cent to the acreage expansion and only 1.45 per cent due to the change in the cropping pattern. The interaction of the yield and the crop pattern contributed 16.91 per cent to increased agricultural production. With the exception of the District of Gurdaspur, the change in productivity contributed more than 50 per cent to increased agricultural production in all the districts in the Punjab. It was only 37.29 per cent in the case of Gurdaspur. In Ludhiana, 57.83 per cent of the change in production was explained by the change in yield only. The rest was explained by other three components. The component of yield contributed to the extent of 66.72 per cent in Patiala, 58.98 per cent in Bhatinda, 58.82 per cent in Ferozepore, 58.38 per cent in Amritsar, 55.43 per cent in Jullundur, 51.92 per cent in Sangrur, and 54.68 per cent in Hoshiarpur.

In the districts of Patiala, Bhatinda, Ludhiana and Jullundur, the change in the crop pattern figured next to yield so far as its contribution to increased production was concerned. The change in the crop pattern contributed to the extent of 25.50 per cent in Patiala, 16.46 per cent in Bhatinda, 3.85 per cent in Ludhiana and 18.51 per cent in Jullundur. In all other districts, next to yield, the acreage expansion was responsible for the increased production of the agricultural output. The acreage expansion contributed to the tune of 26.77 per cent in the Gurdaspur District, 17.03 in the Amritsar District, 17.24 per cent in Kapurthala, 31.01 in Hoshiarpur, 18.72 per cent in Ferozepore and 24.64 per cent in Sangrur.

TABLE 4.4

The relative contribution of area, yield, cropping pattern and other interactions in the districts of the Punjab State, 1960-61 through 1969-70

Districts	Area	Yield	Crop Pattern	Y× C
Gurdaspur ..	26.77	37.29	17.77	15.17
Amritsar ..	17.03	58.38	14.73	12.33
Kapurthala ..	17.24	55.66	16.77	10.32
Jullundur ..	16.17	55.43	18.51	9.89
Hoshiarpur ..	31.01	54.68	8.50	5.81
Ludhiana ..	14.15	57.83	17.45	10.58
Ferozepore ..	18.72	58.82	14.23	8.21
Bhatinda ..	12.28	58.98	16.46	12.28
Sangrur ..	24.64	51.92	9.09	14.35
Patiala ..	—0.65	66.72	25.51	8.42
State ..	15.53	66.11	1.45	16.91

Differentials in Productivity Growth

From the above analysis it is observed that the changes in the yield-rate were mainly responsible for the increased production of the agricultural output in the State. Different districts behaved differently in so far as the rate of growth of productivity was concerned. Here, an attempt is made to study the differentials in the growth of productivity among the different districts of the State during the period 1950-51 through 1969-70. The crops considered were nine in number as under :

(i) Foodgrains : Wheat, rice maize, gram, *bajra.*
(ii) Other crops : Sugarcane, groundnut, cotton American and cotton *desi.*

The district-wise productivity data for these crops were collected from *Statistical Abstracts* and adjusted for change in the area of different districts. The linear function $Y = a + bt$ was fitted to this data. Based on this function, the trend values were calculated for 1950-51, and for 1969-70 for each district and for the State as a whole. These values were further transformed into indexes while taking the State value of the corresponding year as the base equal to 100. This brought all the districts to a common base at both the time periods and made it easier to visualize and trace the change in the productivity of different districts relative to the State average since 1950-51 through 1969-70.

The relative position of different districts in respect of the productivity of various crops selected in the Punjab for 1950-51 and 1969-70 are presented in the following pages.

Wheat : In so far as the productivity of the wheat crop was concerned, Kapurthala, Jullundur, Ferozepore, Sangrur and Ludhiana were above the State level in 1950-51 and Patiala, Bhatinda, Amritsar, Hoshiarpur and Gurdaspur were below the State level. In 1969-70, Patiala, Bhatinda and Amritsar moved over to an index above the State level, whereas Kapurthala, Ferozepore and Sangrur shifted to below the State level of productivity. Ludhiana occupied the fifth rank in 1950-51 of the districts that were above the State level, but improved its position to the first rank in 1969-70, Jullundur fell to the fifth position in 1969-70, as against the second in 1950-51.

Of the districts, which ranked below the State level of productivity, Hoshiarpur went down to the fifth position, whereas Gurdaspur raised its level to the 4th position.

TABLE 4.5

Wheat

Above the State level		Rank	Below the State level	
1950-51	1969-70		1950-51	1969-70
Kapurthala	Ludhiana	1	Patiala	Sangrur
Jullundur	Bhatinda	2	Bhatinda	Ferozepore
Ferozepore	Patiala	3	Amritsar	Kapurthala
Sangrur	Amritsar	4	Hoshiarpur	Gurdaspur
Ludhiana	Jullundur	5	Gurdaspur	Hoshiarpur

Maize : As far as the productivity level of the maize crop is concerned, it has undergone significant changes. In 1950-51, Jullundur, Kapurthala, Ferozepore, Ludhiana, Amritsar, Patiala and Gurdaspur were above the State level of productivity, whereas

TABLE 4.6

Maize

Above the State level		Rank	Below the State level	
1950-51	1969-70		1950-51	1969-70
Jullundur	Ludhiana	1	Hoshiarpur	Patiala
Kapurthala	Sangrur	2	Sangrur	Ferozepore
Ferozepore	Hoshiarpur	3		Amritsar
Ludhiana	Jullundur	4		Kapurthala
Amritsar		5		Gurdaspur
Patiala		6		
Gurdaspur		7		

Hoshiarpur and Sangrur were below the State level. In 1969-70, Hoshiapur and Sangrur improved their position and moved to above the State level of productivity, whereas Ferozepore, Patiala, Amritsar, Kapurthala and Gurdaspur went below the State level. The districts that remained above the State level were Ludhiana and Jullundur. Ludhiana which ranked fourth in 1950-51, improved its position to the first rank and Jullundur, which was at the top, occupied the fourth rank in 1969-70. Hoshiarpur and Sangrur which were below the State level, improved their position to such an extent that Sangrur was ranked second and Hoshiarpur third in 1969-70.

Rice : In the matter of productivity of the rice crops, Amritsar, Jullundur, Ferozepore, Gurdaspur, Hoshiarpur, Sangrur, Kapurthala and Patiala stood above the State level in 1950-51. None of the districts was below the State level. In 1969-70, the districts that maintained the level raised their rank within that level. Kapurthala ranked first in 1969-70 against the seventh position in 1950-51. Patiala ranked eighth in 1950-51 but improved its position to the second rank in 1969-70. Amritsar and Hoshiarpur lowered their positions below the state level. Amritsar, which ranked first in 1950-51, went down to below the State level and was ranked second.

TABLE 4.7

Rice

Above the State level		Rank	Below the State level	
1950-51	1969-70		1950-51	1969-70
Amritsar	Kapurthala	1	..	Gurdaspur
Jullundur	Patiala	2	..	Amritsar
Ferozepore	Sangrur	3	..	Hoshiarpur
Gurdaspur	Jullundur	4		
Hoshiarpur	Ferozepore	5		
Sangrur		6		
Kapurthala		7		
Patiala		8		

Bajra : All the districts were below the state level in 1950-51 so far as the productivity of *bajra* was concerned. In 1969-70, the only district which crossed over to above the State level was Ludhiana. The districts within the category shifted their ranks. Bhatinda raised its position from the fourth to the first. The Sangrur District got the second place in 1969-70 as against the eighth in 1950-51. Ferozepore, Amritsar and Gurdaspur

have lowered their ranks. Jullundur retained the old rank. Gurdaspur which was number one, went down to the seventh rank.

TABLE 4.8

Bajra

Above the State level		Rank	Below the State level	
1950-51	1969-70		1950-51	1969-70
..	Ludhiana	1	Gurdaspur	Bhatinda
		2	Ferozepore	Sangrur
		3	Amritsar	Ferozepore
		4	Bhatinda	Amritsar
		5	Hoshiarpur	Hoshiarpur
		6	Jullundur	Jullundur
		7	Ludhiana	Gurdaspur
		8	Sangrur	

Gram : As regards the productivity level of gram, the districts which were above the State level of productivity in 1950-51 were Kapurthala, Jullundur, Ludhiana, Hoshiarpur and Amritsar. Patiala, Bhatinda and Ferozepore were below the State level of productivity. In 1969-70, all the districts, except Hoshiarpur, were above the State level. Ferozepore, which had the lowest productivity level in 1950-51, raised its position to the top in the category of districts which were above the State level in 1969-70. Amritsar which ranked fifth in 1950-51 improved its position and was ranked second in 1960-70 (Table 4.9).

TABLE 4.9

Gram

Above the State level		Rank	Below the State level	
1950-51	1969-70		1950-51	1969-70
Kapurthala	Ferozepore	1	Patiala	Hoshiarpur
Jullundur	Amritsar	2	Bhatinda	..
Ludhiana	Ludhiana	3	Ferozepore	
Hoshiarpur	Jullundur	4		
Amritsar	Patiala	5		
	Kapurthala	6		
	Bhatinda	7		

Groundnut : As regards Groundnut, the districts above the State level were Ludhiana and Jullundur in 1950-51, whereas Sangrur and Patiala were below the State level. Ludhiana maintained its position and Patiala improved its level of productivity and rose above the State level in 1969-70. Sangrur continued to remain below the State level of productivity and Jullundur went below the State level in 1969-70 (Table 4.10).

TABLE 4.10

Groundnut

Above the State level		Rank	Below the State level	
1950-51	1969-70		1950-51	1969-70
Ludhiana	Ludhiana	1	Sangrur	Sangrur
Jullundur	Patiala	2	Patiala	Jullundur

Sugarcane : In 1950-51, Jullundur, Ludhiana, Ferozepore and Kapurthala districts were above the State level of productivity in so far as sugarcane was concerned. Patiala, Bhatinda, Gurdaspur, Hoshiarpur, Amritsar and Sangrur were below the state level in 1950-51. The districts that remained above the State level changed their position in 1969-70. Ludhiana which ranked second in 1950-51, raised its level and was amongst those districts which were above the State level in 1969-70. Kapurthala went below the State level (Table 4.11).

TABLE 4.11

Sugarcane

Above the State level		Rank	Below the State level	
1950-51	1969-70		1950-51	1969-70
Jullundur	Ludhiana	1	Patiala	Patiala
Ludhiana	Jullundur	2	Bhatinda	Kapurthala
Ferozepore	Ferozepore	3	Gurdaspur	Gurdaspur
Kapurthala	Bhatinda	4	Hoshiarpur	Hoshiarpur
		5	Amritsar	Amritsar
		6	Sangrur	Sangrur

Cotton *desi* : In the case of cotton *desi* the districts above the State level of productivity in 1950-51 were Ferozepore, Sangrur, Ludhiana, Amritsar, Patiala, Bhatinda and Hoshiarpur.

The only district which continued to be above the State level in 1969-70 was Bhatinda. The productivity level of the remaining districts went down when compared with the State level in 1969-70 (Table 4.12).

TABLE 4.12

Cotton (*desi*)

Above the State level		Rank	Below the State level	
1950-51	1969-70		1950-51	1969-70
Ferozepore	Bhatinda	1	..	Ferozepore
Sangrur		2	..	Ludhiana
Ludhiana		3	..	Sangrur
Amritsar		4	..	Patiala
Patiala		5	..	Amritsar
Bhatinda		6	..	Hoshiarpur
Hoshiarpur		7		

Cotton (American) : The productivity of American cotton was above the State level in Sangrur, Patiala and Ludhiana in 1950-51, whereas Amritsar, Bhatinda and Ferozepore were below the State level. In 1969-70, Ferozepore, Bhatinda, Ludhiana and Patiala were above the State level and Sangrur and Amritsar were below the State level. Ferozepore which was at the bottom in 1950-51 amongst the districts that were below the State level moved up above the State level and was ranked first. Bhatinda also rose above the State level and was ranked second, whereas Ludhiana maintained its third position in 1969-70 (Table 4.13).

TABLE 4.13

Cotton (American)

Above the State level		Rank	Below the State level	
1950-51	1969-70		1950-51	1969-70
Sangrur	Ferozepore	1	Amritsar	Sangrur
Patiala	Bhatinda	2	Bhatinda	Amritsar
Ludhiana	Ludhiana	3	Ferozepore	
	Patiala	4		

Low Growth Areas

In order to identify the areas where the growth of productivity was lower than that of other districts, the districts were given scores on the basis of their performance with respect to each crop. Districts that crossed the State level of productivity were given a score of four; the districts that raised their level within a category were given a score of three; and the districts which maintained their level within a category were given a score of two. The districts that lowered their level within a category were given a score of one. Districts that went below the State level were given a score zero.

To arrive at the aggregated score for the district as a whole, the scores were weighted by the proportion of the areas under the respective crops in the district. This was done in order to give weightage to the cropping pattern of the district. On this basis, the average score of the districts were worked out and are given in (Table 4.14).

TABLE 4.14

Average score earned by districts on the basis of their performance in various crop growths of productivity

Districts	Average scores
Bhatinda	3.76
Patiala	3.28
Ludhiana	2.73
Amritsar	2.36
Gurdaspur	1.82
Hoshiarpur	1.63
Ferozepore	1.12
Sangrur	1.10
Jullundur	0.92
Kapurthala	0.63

The highest score was earned by Bhatinda (3.76), followed by Patiala (3.23), Ludhiana (2.73), Amritsar (2.36), Gurdaspur (1.82), Hoshiarpur (1.63), Ferozepore (1.12), Sangrur (1.10), Jullundur (0.92), and Kapurthala (0.63). This put all the districts in order of their growth performance during the period under study. Jullundur and Kapurthala did not show up better in so far as the growth of productivity was concerned. In Bhatinda, Patiala, Ludhiana and Amritsar, the growth of productivity was higher than that in other districts.

Chapter V

THE IMPACT OF FARM TECHNOLOGY ON FARM SIZE, LAND TENURES AND RENTS IN THE PUNJAB

The modern farm technology comprising new seeds of high-yielding varieties of crops, chemical fertilizers, pesticides and farm machinery, has been widely accepted by the virile and imaginative farming community of this State. As a result, the productivity of land has increased manifold and the approach to farming has undergone almost a radical change. Farming as an occupation has made a big leap forward from merely a way of life to that of well-conceived business enterprise. The rapid diffusion of new technology over the whole rural areas has generated several fresh socio-economic interactions.

The new technology has been found sound and suitable, both technically and operationally. It has assured a total return to the farmer, which is greater than before. The return is also considerably greater than the associated fixed and variable costs plus the necessary risk premium, so as to induce the farmers to pursue this occupation with hope and confidence.

The new technology tends to influence and alter the existing pattern of land tenurial system. Statutory rights in land and its cultivation undergo a shift under its influence. It brings about changes in respect of land ownership, occupancy, control, use and land values and rents. In this chapter, an attempt is made to test the various hypotheses related to the changes in the system of land tenures consequent upon the adoption of new farm technology. There is no doubt that the full impact of the adoption of technology on the system of land tenures and allied relationships will take more time to soak into the system, yet substantial evidence even at this stage exists to bring out the trend of the change that is likely to ultimately emerge. The objective of this chapter is to highlight the nature and degree of the influence in this regard as a sequel to the adoption of new technology. To be specific, the impact of new technology has been studied here in respect of four distinct aspects of land tenures, which are :

(i) the size of the farm,
(ii) the shift in tenurial rights,
(iii) the land rents, and
(iv) the sharing of inputs.

The Impact of Farm Technology on the Farm Size

Until recently, the existing agrarian structure in the Punjab was based on customs and established practices, which were voluntarily or compulsorily accepted by the farmers. This is showing signs of a substantial change. In respect of farm size, the basic hypothesis is that the adoption of improved farm technology brings about a shift in the operational size. There is a general tendency among the farmers to raise the size of their farms. A good land-tenure system is the one which contributes to the establishment and maintenance of a rational farm size in relation to other physical and technical resources. The smaller size of the farms reduces the scale of production unit and production becomes more expensive owing to the lack of opportunities for full adoption of farm technology. Small farms are generally labour-intensive, whereas large farms are technical capital-intensive. Since by nature, technology is cost-reducing, an optimum farm size in relation to technology contributes to a rationale in production and in the utilization of resources. This being the situation, one finds that there is always a strong preference for increasing the size of the farm through the purchase or renting in of more land. However, it is to see as to which section of the farmers, whether the small ones, the medium ones, or the large ones are more active in the acquisition of farm land. According to a recent study conducted to identify this phenomenon in the Punjab, the farmers were categorized into the following three farm size groups :

(i) Up to 14.6 acres—small;
(ii) from 14.6 to 29.0 acres—medium; and
(iii) above 29.0 acres—large.

The actual purchases and sales of land effected by the farmers in the above categories were known and are brought out in Table 5.1.

It is evident from Table 5.1 that a much larger proportion of small farmers effected purchases than medium and large farmers. A larger proportion of land purchases, however, were effected by the medium farmers who had, perhaps, both the power and the will to purchase land to add to the size of their farms. Judging from these results, land purchases are clearly favoured by small and medium farmer groups. On the other hand, sales were effected mostly by the large farmers and least by the small ones. In terms of areas, the medium farmers sold the minimum. It is, therefore, evident the medium-sized farmers ranging between 14.6 and 29 acres farm size are on the increase because of increased purchases and diminished sales. Large farms of more than 29 acres would naturally be on the decline

TABLE 5.1

Purchase and sales of land effected by small, medium and large farmers in the Punjab 1967-68 to 1969-70

Categories	Purchases		Sales		
	No. of farmers	Percentage of farmers purchasing land	Percentage of purchased land	Percentage of farmers who sold land	Percentage of sold land
Small	45	12.02	3.37	7.14	4.35
Medium	43	11.06	8.99	12.5	0.70
Large	21	4.76	0.46	23.8	3.25

in number because of sales larger than purchases. Small farmers also seem to be investing in land with a view to increasing the size of their ownerships through purchases. These are, no doubt, healthy trends, as both the small and the large categories of farmers are apparently being converted into the middle-class peasantry group which is becoming stronger in the Punjab. Such a trend of distribution of land among the various categories of farmers is looked upon both as rational and equitable. Since this phenomenon is of recent development, it is evident that new farm technology is the major factor contributing to this shift.

The shifting farm-size situation as emerging in the Punjab, and favouring the small and medium farmers to increase their farm-sizes apparently appears to be in contradiction with the theory which draws up on the hypothesis that the large farmers start purchasing more and more land with the adoption of new agricultural technology. But the trend of this situation is not difficult to explain in respect of the Punjab, where much social prestige is attached to the ownership of land, and where the alternative occupational opportunities are lacking. The institutional factors, like the joint-family system which favours the pooling up of the resources for the purchase of land by the small and medium farmers also go a long way in assisting this process.

Shifts in Tenurial Rights

The farm technology has seemingly brought about substantial shifts in the proportion of the land held under various types of land rights. This is evident from Table 5.2, which indicates

that as compared with 84.17 per cent of the area under ownership cultivation in 1967-68, it decreased only slightly to 82.91 and 80.89 per cent in 1968-69 and 1969-70 respectively. The area under tenant cultivation increased from 15.83 per cent in 1967-68 to 19.11 per cent in 1969-70. The annual reports on the Land Revenue Administration, Punjab for the year 1961-62 indicate that out of a total 7666.75 thousand hectares under cultivation, 5263.32 thousand and 2403.43 thousand were under ownership cultivation and tenant cultivation respectively. It was further observed that out of the total area of 2404.43 thousand hectares under tenant cultivation, 17.68 thousand and 2385.75 thousand giving percentages of 0.23 and 31.12 of the total area under cultivation was under occupancy tenants and tenants at will respectively. It leads to the conclusion that the tenancy at will has sharply declined to 15.83 per cent in 1967-68. However, in the succeeding two years it registered a slight increase.

Barring individual exceptions, the tenants in the Punjab do not comprise a clear-cut class by itself. Their main body consists of small owners who are partly tenants. As such, the tenants are dispersed over the entire State and constitute a major farming class in the rural Punjab. It is a common practice observed by the small owners to take land on rent for enlarging their operational holding. Renting out, however, is largely done by such land-owners as widows, minors and absentee owners in defence, and other public and private service.

TABLE 5.2

Shifts in proportion of land under various types of land rights in the Punjab, 1967-68 to 1969-70 (Area in hectares)

Year	Owned cultivation		Tenant cultivation			Total	
	Area	Percentage	Occupancy tenants	Tenants at will		Area	Percentage
			Area	Area	Percentage		
1967-68	1110.09	84.17	..	208.74	15.83	1318.83	100
1968-69	1114.28	82.91	..	229.70	17.09	1343.98	100
1969-70	1117.10	80.89	..	263.88	19.11	1380.98	100

*Tenants at will mostly comprise the small owner-cum-tenants

New agricultural technology has enhanced the profitability of agriculture and an increasing number of families in the rural

areas have started self-cultivation. The important feature of the developing situation is that the tenants, as a distinct class, have almost disappeared and have been replaced by either owner cultivation or owner-*cum*-tenant cultivation. The impact of new agricultural technology is discernible in respect of the activisation of small owners who are tempted to increase the size of their operational holdings in order to make them more viable. This, however, does not indicate in any way a tendency of decline in the owner-cultivation in the Punjab. It has simply strengthened owner-*cum*-tenant cultivation and, thus, resulted in a more rational use of resources.

The different land-reform measures, including the consolidation of holdings enforced in the Punjab from time to time also aimed at achieving a shift in favour of owner-cultivation. This guaranteed greater investment and adoption of improved practices on the farm, resulting in higher production. The rapid adoption of new technology was assisted by a land reform to bring about a change in favour of owner cultivation. The Punjab has, thus, become predominantly owner-operated agricultural State.

Annual Rental Value of Land

Consequent upon the manifold increase in the productivity of land under the impact of new farm technology, the value of land was naturally bound to increase. The price-support policy in respect of major cereals has also contributed much to this change. Gross returns from land have sharply increased in recent years. As a consequence, the marginal productivity of agricultural worker has gone up significantly. The overall demand for agricultural commodities and the accompanied profitability of their production have caused an increasing demand for land. Land, therefore, has witnessed a sharp rise in its rental value. This is brought out in Table 5.3.

As shown in Table 5 .3 land rents of irrigated land increased by 35.45 per cent in 1968-69 and by 38.90 per cent in 1969-70 as compared with those in 1967-68. This increase in the rent of irrigated land is the result of the adoption of new farm technology, particularly the seed of high-yielding varieties of wheat, rice, maize and *bajra*. The rental value of unirrigated land and its rate of increase, was much less for obvious reasons.

It is interesting to learn that in certain districts, such as Ludhiana and Jullundur in which the degree of adoption of modern technology is much more marked than in the rest, the rents of land have risen to as high as Rs 500 to Rs 600 per acre in the recent

TABLE 5.3

Extent of rise in land rents in the Punjab in recent years

Type of land	Year	Rs per acre	Percentage increase over 1967-68
Irrigated	1967-68	301.50	..
Irrigated	1968-69	408.39	35.54
Irrigated	1969-70	418.80	38.90
Unirrigated	1967-68	190.00	..
Unirrigated	1968-69	231.00	21.58
Unirrigated	1969-70	245.35	29.13

years. The predominance of small holders in such districts as Hoshiarpur is also an additional factor for this increase in rent.

The rents and also the values of land in a situation of the present type characterized by competition among a large number of bidders and users of land, and by the rising price expectation are bound to rise in the Punjab in the years to come.

The establishment of the legal control of land rents and values will have a favourable effect on the agricultural development of the Punjab. The control of rents will guarantee the tenant an adequate standard of living and give him an incentive for additional efforts involved in the investment on the farm. This, however, does not mean that the land rents should be reduced unreasonably, failing which the land owner will fail to perform his function as a landlord. It must take care of the improvements made by the landlord on land.

An F.A.O. study[1] pointed out in this connection, "Rent reduction will, in general, lead to reduction of land values by changing the terms of the individual lease in favour of the tenant. A moderate reduction of land values is not, however, detrimental to agricultural production, but on the contrary, it may be to its advantage".

1. F.A.O. 1953. Inter-relationship between agrarian reform and agricultural development. Agricultural Studies No. 26, Rome, Italy, p. 37.

Cash and Kind Rents

The adoption of the new farm technology has brought about a change in the mode of the payment of rent. This shift has been in favour of cash rent. Until recently, low productivity, instability of agriculture and low returns from the cultivation of land, for a very long time, were mainly responsible for rent in kind. Thus, the rent in kind, with rare exceptions, was a general rule. But the introduction of new technology has substantially changed the situation, resulting in preference for cash rent to the rent in kind. This influence of the new technology has been brought out in Table 5.4.

TABLE 5.4

The proportion of land under cash rents and rents in kind paid by tenants in the Punjab, 1967-68 to 1969-70 (Area in hectares)

Year	Under cash rents		Under rent in kind		Total	
	Area	Percentage	Area	Percentage	Area	Percentage
1967-68	96.10	46.04	112.64	53.96	208.74	100
1968-69	116.73	50.82	112.97	49.18	229.70	100
1969-70	151.52	57.38	112.56	42.62	264.08	100

Table 5.4 reveals that cash rents are now much commoner than rents in kind. The area under cash rents increased from 46.04 per cent of the total cultivated area in 1967-68 to 50.82 per cent in 1968-69 and further climbed to 57.38 per cent in 1969-70. The results of this study were compared with the findings of the "Annual Reports on the Land Revenue Administration" for 1961-62. According to this report, 2385.75 thousand hectares area was cultivated on rent. Of this, 623.81 thousand and 1761.94 thousand giving percentages of 26.15 and 73.85 were under cash rent and rent in kind respectively. Obviously, the significant increase in the proportion of cash rents reported in the sample study, came due to the adoption of new technology. This means as agriculture becomes more profitable, cash rents gain preference to the rents in kind.

Sharing of Input Costs

In respect of the rent in kind, the modern technology has brought about a change in the conventional sharing of the costs of inputs between the tenant and the land-owner. Modern

technology makes use of more purchased inputs, whereas the traditional methods of cultivation proceeded more on the home supplied.

In the traditional system of rents in kind, almost all operational costs of cultivation were borne fully by the tenants. But the situation has now changed, because the increase in production is mainly influenced by the application of costly inputs and the sharing of this cost has become necessary for land-owners. In this way the owner, who is usually more resourceful than the tenant, is able to ensure a much larger quantity of the rent in kind. The tenant also stands to gain, because the assured intensive use of his labour and capital is much better rewarded. The risks involved in incurring the costs of inputs of cultivation also get distributed equally.

The F.A.O. study[1] pointed out, "Unless the shares are based on the actual contributions of the two parties to production, and vary as these contributions vary, the share rent tenant is likely to abstain from using additional fertilizer, better seeds and improved agricultural methods, since his share in the benefits derived may not cover his additional efforts and investments". Thus the sharing of the costs of various inputs used in raising agricultural production hardly be overemphasized.

It was observed that the sharing of costs is done for the following inputs :

(i) seed,
(ii) fertilizer,
(iii) irrigation, and
(iv) pesticides.

TABLE 5.5

The sharing of input costs between the land-owners and the tenants under the system of charging rent in kind in the Punjab (Percentage)

Year	Seed		Fertilizer		Irrigation		Pesticides	
	Owner	Tenant	Owner	Tenant	Owner	Tenant	Owner	Tenant
1967-68	50	50	50	50	40	60	50	50
1968-69	50	50	50	50	40	60	50	50
1969-70	50	50	50	50	40	60	50	50

1. F.A.O. 1953, Agricultural Studies No. 26. *op. cit.* p.37.

The share of costs of each input borne by the owner of land and the tenant in the Punjab in recent years is brought out in Table 5.5.

It was observed that except for the irrigation charges which were 40 per cent for the owner, the cost of all other inputs was borne in the ratio of 50:50. We may say that, by and large, the input costs are borne half and half.

Conclusions

Farm technology is gradually bringing about a shift in the pattern of the farm size. The small and medium holders of land are increasing the size of their farms through purchases. Most of the sales of land are made by large holders. Small owners rented some land to make their unit of cultivation viable. Thus the proportion of owner-*cum*-tenant increased slightly.

Cash rents have become more popular than rents in kind. The area under cash rent increased from 46.04 per cent of the rented land in 1967-68 to 57.42 per cent in 1969-70. Correspondingly, there was a decrease in the area under rent in kind, being 53.96 per cent in 1967-68 and 42.56 per cent in 1969-70. Cash rents increased on an average, from Rs 301.50 in 1967-68 to Rs 418.50 in 1969-70 on irrigated lands. This marked an increase of 38.90 per cent. In respect of rents in kind, the produce was shared half and half by the land-owners and the tenants, but the costs of essential technical inputs were also shared half and half by them, except, for irrigation where sharing was in the proportion of 40:60.

Chapter VI

DEMAND AND SUPPLY PROJECTIONS FOR MAJOR AGRICULTURAL COMMODITIES

Demand Projections

The process of economic development often brings about discernible changes in the demand for agricultural products, which affect the very nature and extent of their flow from the farms to the consumers. If this flow is impeded or gets distorted, national growth may be greatly hampered, because there might not be sufficient demand to clear the markets, or there may not be sufficient supplies to meet the boost-up demand. It is, therefore, essential to have reasonably accurate estimates of the requirements of agricultural products, especially food products over the planned periods of development in order to improve the national efforts at economic planning.

In this exploratory study, the magnitudes and changes in food demand are investigated for the Punjab State as they would be at the end of the Fourth, Fifth and Sixth Plans. The estimation of demand for food can be made from two angles : (1) based on the future requirements arising from the growth in population and increased income per head as a result of planned development, (2) based on the future requirements from the nutritional point of view. In this study, the former approach has been adopted to estimate the effective demand for various food products.

The rate of income growth per head might vary, depending upon the population growth, affected by the birth- and death-rates, the success of the family planning programmes and the general growth of the National economy. Similarly, the income elasticity of demand is dependent upon the base-period consumption, the changes in consumption habits, the customs and the tastes over time and the relative price levels of different commodities. For this attempt to estimate the future requirements in respect of foodgrains, fruits, vegetables and milk products for the Punjab, at the end of the Fourth, Fifth and Sixth Five-Year Plans, the data for the analysis is drawn from different sources : (1) the base-period consumption levels of food products per head, as estimated by N.S.S. in the 19th Round Enquiry[1] and (2) the official statistics of the Punjab State for population, income per head, etc[2].

1 The data of 19th round are as yet being processed by the Board of Economic Enquiry, Punjab.

2 *Statistical Abstract of Punjab*, 1968.

Population projections are usually based on a few vital assumptions, such as those on fertility, mortality and migratory factors, in particular, and the impact of socio-economic development and medical improvements, in general. Through the period 1951-61, the population of the State grew at the rate of 2.3% per annum. This rate is believed to have increased further after 1961, and in 1968 it is estimated to be 2.5 to 2.6. Further, in spite of the intensive family-planning efforts, the population growth in the State is not likely to get stabilized or to decline in the immediate future. However, because of the lack of definite growth-rate figures in the future, we have adopted 3 alternative population-growth estimates for use in our demand estimates, as in Table 6.1. The most conservative projection

TABLE 6.1

Growth-rates used for estimating the population projections in the Punjab (1965 through 1983)

Year	Growth-rates used		
	Alternative I	Alternative II	Alternative III
1965 ..	2.4	2.4	2.5
1968 ..	2.5	2.5	2.6
1973 ..	2.6	2.6	2.7
1978 ..	2.6	2.7	2.8
1983 ..	2.5	2.7	2.8

(alternative-I) is based on the assumption of a moderate growth rate, which gets stabilized after a decade and then slowly starts declining. The second estimate (alternative-II) is based on the assumption of a moderate growth-rate getting stabilized comparatively late. The third estimate (alternative-III) is based on the assumption of a high growth-rate getting stabilized late. Table 6.2 shows the population projections based on these three alternative assumptions.

Further, breakdown in the rural and urban population was considered to be necessary, as the expenditure on different consumption items per head in rural areas differs significantly from that in the urban areas, as will be shown later. Thus, the ratio of rural-urban population which remained stable at 77:23 through the period 1951-68, is assumed to become 75:25 during the period under reference.

The Base-Period Consumption

Estimates of consumption of different farm products per head in the Punjab are available for 1964-65 from the N.S.S.

TABLE 6.2

The population projection for the Punjab with different growth-rate assumption, 1965-1983

Year	Situation I				Situation II				Situation III			
	G.R.	Population			G.R.	Population			G.R.	Population		
		Rural	Urban	Total		Rural	Urban	Total		Rural	Urban	Total
1961	..	8,567,763	2,567,396	11,145,069	..	8,567,763	2,567,306	11,135,069	..	8,567,763	2,567,306	11,135,069
1965	2.4	9,186,432	3,062,144	12,248,576	2.4	9,186,432	3,062,144	12,248,576	2.5	9,219,837	3,073,279	12,293,116
1968	2.5	9,884,600	3,294,867	13,179,467	2.5	9,884,600	3,294,867	13,179,467	2.6	9,957,424	3,319,141	13,276,565
1975	2.6	11,248,675	3,749,558	14,998,233	2.6	11,248,675	3,749,558	14,998,233	2.7	11,381,335	3,793,778	15,175,114
1978	2.6	12,800,992	4,266,997	17,067,989	2.7	12,857,235	4,285,745	17,142,980	2.8	13,065,775	4,355,258	17,421,031
1983	2.5	14,477,921	4,825,974	19,303,895	2.7	14,695,819	4,898,606	19,594,426	2.8	14,999,507	4,999,836	19,999,343

*The actual growth-rate of the Punjab population has been 2.3 during the period 1951-61.
**The estimates of the Director of Economics and Statistics Punjab show higher population estimates at 13,610,856 in 1968. This is due to the growth-rate of 3.1 assumed by them for the period 1961-66 and 2.90 for 1966.

19th Round data. This forms the base for our projections of consumption requirements in the future and also for working out the elasticity coefficients for different food items. Table 6.3 provides the estimated monthly food consumption per head for the Punjab, separately for the rural and the urban sectors during 1964-65.

TABLE 6.3

Estimates for the average monthly consumption of various commodities (kg./month) per head for rural and urban areas in the Punjab in the base period (1964-65)

Items	Rural	Urban
Rice ..	0.89	0.51
Wheat ..	11.42	9.92
Maize ..	2.01	1.16
Other cereals ..	0.38	0.13
Total cereals ..	14.70	11.72
Pulses ..	1.04	0.88
Foodgrains ..	15.74	12.60
Fruit and vegetables ..	2.23	3.07
Milk and milk products ..	5.90	4.20

The composition of foodgrains consumed in the rural as well as in the urban areas in Punjab, thus, turns out to be predominantly wheat, followed by maize and pulses. The consumption of grains and milk and milk products is generally higher in the rural sector, whereas the consumption of fruits and vegetables is higher in the urban sector. It is interesting to note that the base-period consumption of cereals (1964-65) in the Punjab is as high as the estimated cereal consumption in India in 1983-84.[1] This suggests that the elasticity of consumption of cereals in the State should be very low, may be zero, in the future.

Estimate of Income Per Head

Income projections per head depend upon the rate of growth of population and the overall growth of the national income. Bases for population projections have been discussed already in the earlier section. On the basis of the investments proposed in the Fourth Five-Year Plan, the total income of the State is expected to go up by 6.7% per annum (compound), as against 5 per cent of the country as a whole. But the past performance does not seem to justify this high growth-rate. The State income

1. Ray, S. K. 1969. Demand for food in India, 1968-69 to 1983-84. Paper read at the Seminar on Long-range Agricultural Adjustment Analysis, held at U.S.A.I.D., New Delhi.

at 1952-53 prices increased at the rate of 3.7 per cent during the period 1952-53 through 1960-61. It grew at the rate of 4.8% per annum during the period 1960-61 through 1965-66. The corresponding rates of growth of income for the country as a a whole were 3.8 and 4.2 per cent respectively at 1948-49 prices. These growth figures do, however, provide a logic in assuming the rate of growth of the State income a little higher than the rate at which the national income would grow. With this in mind, we, in this analysis, assume the State income to grow at the rate of 6% per annum during the Fourth Plan, 7 per cent during the Fifth Plan and 8% during Sixth Plan. We do not assume that the growth curve will flatten out within a decade and a half owing to the wast potentials of the State to move on the growth path at an accelerated rate at least in the near future period of two to three decades.

If these desired (assumed) growth-rates of income are achieved, the projections of the disposable income will depend on further assumptions on the anticipated rate of domestic savings. Because of the serious limitations involved in the projections of disposable income, we have based our demand projections on income per head and on income elasticity coefficients. The estimates of income per head for the rural and the urban sectors are obtained from the relations :

$Yr = C\ Yu$ and

$Yu = Y/[cp_r + P_u]$

Where

Yr=Income per head for the rural sector
Yu=Income per head for the urban sector
Pr=Population in the rural sector
Pu=Population in the urban sector
Y=The estimate of aggregate income
C=Ratio of expenditure per head for the rural and the urban sectors, as obtained from the N.S.S. 19th Round (which worked out to be .86).

The projections of the State income and income per head, so worked out separately for all the three situations and for the rural and urban sectors are shown in Table 6.4.

Estimates of Income Elasticities of Demand

The income elasticities of demand were worked out by fitting a double logarthmic function, i.e $\log y = \log a + b \log x$, where the estimates of income elasticity are given by the parametre 'b'. 'y' refers to the consumption (in quantity terms) per head and 'x' refers to the disposable income per head. These elasticities were

TABLE 6.4

Projections of State income per head at constant prices (1951-52) in the rural and urban areas of the Punjab

Year	State income (Rs. crores)	Situation I			Situation II			Situation III		
		Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
1965-66	532.1*	417.57	485.55	434.41	417.57	485.55	434.41	415.91	483.62	432.84
1968-69	636.70	464.18	539.75	483.09	464.18	539.75	483.09	460.79	535.81	479.56
1973-74	852.00	545.85	634.72	568.06	545.85	634.72	568.06	539.49	627.32	561.44
1978-79	1195.00	672.76	782.28	700.14	669.81	778.85	697.07	659.12	766.42	685.90
1983-84	1755.00	873.59	1015.80	909.14	860.63	1000.74	895.65	843.20	980.47	877.53

*Actual, as reported in Statistical Abstract of Punjab, 1968, the total income per head as well as its break-up in the rural and urban income per head have, however, been based on our population estimate, as given in Table 6.2.

worked out for the rural and urban sectors separately, based on the data on consumption patterns obtained from the National Sample Survey 19th round, 1964-65 (Table 6.5).

TABLE 6.5

Income elasticities of demand

Items		Rural	Urban
Wheat	..	.5176	.3383
Maize	..	—.0845	—.2574
Rice	..	.0593	.2951
Cereals	...	.5950	.2882
Pulses	..	.4325	.3408
Foodgrains	..	.4433	.2785
Fruits & vegetables	..	1.0700	.9500
Milk	..	1.5100	.7092

With the passage of time, however, the elasticity coefficients are subject to change, depending upon the nature of the food products to be consumed and the current level of their absolute consumption.

The current level of consumption per head of some of the products, such as the cereals, is higher in the State than that in India as a whole. One has to be, therefore, cautious while making use of fixed elasticities (of 1964-65 in this case) for such products. This is especially true for the products in which case the current consumption level is high and the income elasticity also works out to be high in the base period 1964-65, i.e. (four years back). We have, therefore, made some assumptions about the income elasticity coefficients for such products while projecting the demand per head. For example, our estimates for 1973-74 for cereals are 16.70 kg. per month for the rural section in the case of situations I and II, and 17.29 kg. per month in the case of situation III. The estimated consumption per head for the urban sector for the same period is 12.50 kg. per month in the case of situations I and II, and 12.72 kg. in the case of situation III. For rural sector, this is the maximum average consumption of cereals (17.29) that can be achieved. Even this is too high. At such a high level of foodgrains (cereals) availability, the consumption pattern changes to more of protective foods and more of the cereals start being used as animal feeds. If, however, we project with the same income elasticity, the estimated demand per head would work out between 26 and 28 kg. per month for 1978-79 and 1983-84 respectively. These are absurd figures emerging from the assumption of a

fixed elasticity coefficient. We, therefore, make an assumption of zero elasticity for such products as the total cereals, for the rural sector from 1973-74 onwards. Since maize consumption shows a negative income elasticity, this permits other cereals (especially wheat) to keep increasing. But by 1978-79 even the elasticity for wheat consumption would go down to zero.

In using these elasticity coefficients for demand projections, it is assumed, in addition, that the structure of population, their occupational subdivisions as well as the relative prices of agricultural commodities (food products), will remain unchanged over the period of projection. The assumption is not too unrealistic, as the demand for agricultural commodities is less susceptible to changes due to a high degree of stability in tastes and habits of the people over a short period, i.e. a decade or so. To the extent, however, these changes take place, the elasticity estimates and the demand projection will go wrong.

Estimated Demand for Selected Commodities

To estimate the aggregate demand for food items, the methodology followed is to estimate the consumption per head in the rural sector as well as in the urban sector and to multiply it by the corresponding projected population at the end of the projected period. The absolute population figures for rural and urban areas are used, instead of the standard adult-consumption units, as the elasticities derived from the household-consumption survey were not based on the concept of the adult-consumption unit. The estimate of demand per head for each item, both for the rural and urban sectors for all three situations, is determined by using the relationships $dit = \frac{dio}{Yo} [Yo + e_1(Y_t - Yo)]$

Where dit = consumption demand for ith commodity in the year t
dio = consumption demand for ith commodity in the base period
Yo = income per head in the base period
Y_t = income per head in t period.
e_1 = Income elasticity coefficient.

The projected demand per head for the selected commodities, worked out with the method described above, is presented in Table 6.6 and for three population situations and for the rural and urban sectors separately.

The Punjab State is already at the higher level of cereal consumption. The consumption of cereals per head in the urban and rural sector was estimated at 11.72 kg. per month and 14.70 kg. per month respectively in 1964-65, whereas the projected demands for the all-India urban and rural sectors are 11.32 kg.

TABLE 6.6

The consumption demand per head for different food items (kg./month)

Item	1964-65		1968-69		1973-74		1978-79		1983-84	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
SITUATION I										
Rice	.89	.51	.90	.53	.91	.55	.91	.61	.95	.67
Wheat	11.42	9.92	12.08	10.29	13.23	10.81	14.03	11.97	14.03	13.58
Maize	2.01	1.16	1.99	1.13	1.96	1.08	1.76	0.98	1.70	0.83
Cereals	14.70	11.72	15.68	12.05	16.70	12.50	16.70	13.51	16.70	15.06
Pulses	1.04	0.88	1.09	.91	1.18	.96	1.21	1.06	1.53	1.17
Foodgrains	15.74	12.60	16.77	12.96	17.88	13.46	17.91	14.57	18.23	16.23
Fruits and vegetables	2.25	3.07	2.50	3.39	2.96	3.84	3.69	4.85	4.83	6.25
Milk and milk products	5.90	4.20	6.89	5.03	8.64	6.19	11.34	8.77	15.63	12.36
SITUATION II										
Rice	.89	.51	.90	.53	.91	.55	.92	.60	.95	.67
Wheat	11.42	9.92	12.08	10.29	13.23	10.81	14.09	11.95	14.09	13.46
Maize	2.01	1.16	1.99	1.13	1.96	1.08	1.86	0.98	1.73	0.84
Cereals	14.70	11.72	15.68	12.05	16.70	12.50	16.78	13.76	16.78	15.30
Pulses	1.04	0.88	1.09	.91	1.18	.96	1.31	1.06	1.51	1.30
Foodgrains	15.74	12.60	16.77	12.96	17.88	13.46	18.00	14.82	18.29	16.60
Fruits and vegetables	2.23	3.07	2.50	3.39	2.96	3.54	3.67	4.83	4.76	6.16
Milk and milk products	5.90	4.20	6.89	5.03	8.64	6.19	11.28	8.71	15.35	12.13

	SITUATION III									
Rice	.89	.51	.90	.53	.91	.55	.92	.60	.94	.66
Wheat	11.42	9.92	12.06	10.28	13.18	10.91	14.37	11.88	14.37	13.37
Maize	2.01	1.16	1.93	1.13	1.96	1.07	1.89	.91	1.84	.85
Cereals	14.70	11.72	15.64	12.08	17.29	12.72	17.29	13.69	17.29	15.19
Pulses	1.04	0.88	1.09	.91	1.17	.97	1.30	1.05	1.50	1.19
Foodgrains	15.74	12.60	16.75	12.90	18.46	13.70	18.50	14.74	18.79	16.38
Fruits and vegetables	2.23	3.07	2.49	3.58	2.94	3.93	3.62	4.77	4.68	6.06
Milk and milk products	5.90	4.20	6.86	5.01	8.55	6.42	11.11	8.57	15.05	11.88

and 14.40 kg. per month for 1983-84. This indicates Punjab's consumption of cereal has reached almost the peak and consumption from this point should tend to flatten out. During the period of 20 years, i.e. 1964-65 through 1983-84, the per head consumption of cereals is thus estimated to increase to 16.70 and 15.06 kg. per month for rural and urban sectors respectively for situation I, 16.78 and 15.30 kg. per month for situation II and 17.29 and 15.19 kg. per month for situation III from the base period consumption of 14.70 and 11.72 kg. per month for rural and urban sectors respectively. Punjab comprises mostly of wheat-eating population, where wheat forms about 80 per cent of the total cereal consumption. The rest of the 20 per cent comes from rice, maize and other cereals. Pulses are major source of proteins and form an important constituent of a balanced diet. But the consumption of pulses does not show a very healthy trend. The largest increase, however, is likely to come in the case of fruits and vegetables, milk and milk products. For these two products the consumption demand in 1983-84 will be more than double that of the base period. Table 6.7 provides the projected aggregate demand for selected items up to 1983-84 for all the three situations separately based on different assumptions of growth. Appendix I to III provide the rural and urban breakdown of the corresponding estimates for all the three situations.

These projections throw out some interesting results on the future consumption requirements for different items during the next three plans. According to the most conservative estimate (situation I), the total cereal requirements for consumption will increase from 23.36 lakh tonnes in 1968-69 to 37.73 lakh tonnes in 1983-84. For pulses, the increase will be from 1.65 to 3.57 lakh tonnes. For all foodgrains, the demand will increase from 25.01 to 41.07 lakh tonnes during this period (almost double the quantity consumed in 1964-65). Under situation II of the population growth, the cereal requirements for consumption will increase from 23.36 to 39.58 lakh tonnes, pulses from 1.65 to 3.42 lakh tonnes and foodgrains from 25.01 to 43.01 lakh tonnes during this period. In the case of situation III of the population projections, based on the assumption of a higher rate of population growth, the consumption requirements for cereals in 1983-84 would go up to 41.30 lakh tonnes and all foodgrains to 44.78 lakh tonnes. The demand for fruits and vegetables and milk and milk products will be almost three times the estimated demand for 1968-69.

Non-human Consumption

Since the cereal consumption is high in the State and the

TABLE 6.7

The aggregate projected demand for different food items in the Punjab (000 tonnes)

Year	Rice	Wheat	Maize	Cereals	Pulses	Foodgrains	Fruits and vegetables	Milk and milk products
			Situation I (Low growth-rate that gets levelled off earlier)					
1964-65	116.88	1623.36	262.24	2051.04	147.00	2198.04	358.56	804.72
1968-69	127.68	1839.72	280.68	2336.32	165.24	2501.56	430.56	1016.16
1973-74	147.60	2272.20	313.20	2816.65	202.44	3019.09	574.28	1444.68
1978-79	172.08	2732.09	343.44	3257.08	240.14	3497.22	815.16	2190.86
1983-84	202.88	3199.93	366.00	3773.52	333.65	4107.08	1201.08	3431.16
			Situation II (Low growth-rate that gets levelled off later)					
1964-65	116.88	1623.36	262.24	2051.05	147.00	2198.04	358.56	804.72
1968-69	127.68	1839.72	280.68	2336.32	165.24	2501.56	430.56	1016.16
1973-74	147.60	2272.20	313.20	2816.65	202.44	3019.09	574.28	1444.68
1978-79	172.80	2779.04	344.12	3296.52	256.56	3553.18	814.63	2188.32
1983-84	204.88	3291.81	372.12	3958.48	342.71	4301.19	1201.56	3440.00
			Situation III (High growth-rate that gets levelled off later)					
1964-65	117.24	1629.36	265.16	2058.60	147.48	2206.08	360.00	807.60
1968-69	128.64	1850.52	270.79	2349.96	166.44	2516.40	432.12	1019.28
1973-74	149.28	2296.80	316.32	2940.48	204.00	3144.48	580.44	1460.04
1978-79	175.56	2953.56	347.03	3626.36	258.72	3785.08	816.84	2189.88
1983-84	208.80	3478.68	382.18	4130.68	347.40	4478.08	1206.00	3451.68

increase in it is likely to flatten out soon owing to the increasing incomes, consumption of milk and milk products, meat and eggs is going to increase appreciably during this period. Milk and milk products are estimated to increase more than 3 times during this period. This development suggests a higher consumption of grains, especially maize, for animal feeds. The State Government efforts in the direction of development of dairy and poultry industry in the State, thus, is going to have a favourable response from the farmers. On the other side, wastage will be reduced owing to the development of better handling and scientific storage facilities. Seed requirements will almost remain the same as a percentage of the total consumption. If at all it changes it will probably decline owing to the introduction of high-yielding varieties of crops, which have high production-seed ratio. Although, it is difficult to exactly quantify the increase in the non-human consumption, yet the direction is clear and it will not be very unrealistic to assume this increase as under :

Period	Assumed non-human consumption as percentage of human consumption
1964-65 to 1968-69	10
1968-69 to 1973-74	11
1973-74 to 1978-79	13
1978-79 to 1983-84	15

This trend, or at least the pace, might however get arrested, if unfortunately owing to a heavier demand from outside the State, the prices of foodgrains shoot up and it becomes relatively less profitable to convert the grains into milk, meat and eggs. At this point of time, however, the situation seems to be encouraging and it does not seem to be unrealistic to make these assumptions on non-human grain consumption. The total cereal consumption on this basis will, thus, go up as shown in Table 6.8.

Table 6.9 summarizes the increase in the food requirements of the State in terms of percentage increase in total demand for various items during the next 15 years, i.e. 1968-69 through 1983-84, indicating the relative importance and shifts in importance of different items in the consumers' demand over this period.

Amongst cereals, the maximum percentage increase in demand is thus noticed in the case of wheat followed by rice and maize.

TABLE 6.8

Human, non-human and total foodgrains consumption, in the Punjab State under three population situations 1964-65 through 1983-84

Year	Human consumption			Non-human consumption			Total demand		
	SITUATION			SITUATION			SITUATION		
	I	II	III	I	II	III	I	II	III
1964-65	2051.04	2051.04	2058.60	205.10	205.10	205.86	2256.14	2256.14	2264.46
1968-69	2336.32	2336.32	2349.96	233.63	233.63	234.99	2569.95	2569.95	2584.95
1973-74	2816.65	2816.65	2940.48	309.83	309.83	326.45	3126.48	3126.48	3263.93
1978-79	3257.08	3296.52	3526.36	423.42	428.54	458.42	3680.50	3725.06	3984.78
1983-84	3773.52	3958.48	4130.68	566.02	593.77	619.60	4339.54	4552.25	4750.28

TABLE 6.9

Percentage increase in consumers' demand during 1968-69 through 1983-84

Items	Situation I	Situation II	Situation III
Rice	58.89	58.89	62.31
Wheat	73.99	78.92	87.95
Maize	30.71	32.58	41.13
Cereals	61.53	69.43	75.77
Pulses	101.86	107.40	108.72
Foodgrains	64.18	71.94	77.95
Fruits and vegetables	178.95	179.07	179.09
Milk and milk products	237.66	238.52	239.82

Of all the items, the demand for milk would record the highest percentage increase being 237.66, 238.52, 239.82 per cent for low, medium and high population estimates respectively. The next highest increase is for fruits and vegetables with 178.95, 179.57 and 179.09 per cent increase in demand for the three situations.

Supply Projections

In this section an attempt has been made to project the supply of major foodgrains** in the Punjab State as it would be at the end of the fourth, fifth and sixth plan periods. Four crops, i.e. wheat, maize, *bajra*, and paddy, have been considered in this study. These crops cover 79 per cent of the acreage under foodgrains and contribute 90% to the foodgrain production in the Punjab. All cereals together account for 91% of the total foodgrains. This means 97% of the cereal crops are accounted for by these four crops. The percentage share of the cereals in foodgrains production is on the increase. It has gone up from 76 per cent in 1960-61 to 91% in 1967-68, as detailed below:

Year	Foodgrain production (000 tonnes)	Cereal production (000 tonnes)	Production of selected crops (wheat, maize, rice & *bajra*) (000 tonnes)	Cereals as percentage of the total foodgrains production	Selected cereals as percentage of the total foodgrains production
1960-61	3,196	2,442	2,390	76.3	74.7
1967-68	5,368	4,883	4,732	90.9	88.1

**Supply here is taken as equal to production. The State being surplus in foodgrains, the whole of the additional production becomes supply in the absence of any sizeable storage capacities with the farmers.

The production of a crop depends upon the acreage under the crop and the yield per acre. The yield of the crop, in turn, depends upon the use of several factor inputs, such as manures and fertilizers, irrigation, improved seeds, efficient control of diseases through plant-protection measures along with such other factors as are beyond control of the farmers, viz. variation in rainfall, temperature, humidity etc. In projecting the supply of these commodities only the controllable factors have been taken into consideration. Certain assumptions with regard to the direction and tempo of economic development, behavioural responses of the farmer to the price and the direction of the Government policies have been made. It is assumed that developmental investment in agriculture will continue at a trend rate and farmers will respond to price incentives and disincentives as they would affect the profitability of different crops. Since India has been facing an acute shortages of foodgrains and is still importing them, it is assumed that the Government policies will not turn the terms of trade unfavourable to the foodgrain crops in India. The supply of foodgrains here has been assumed to be directly dependent upon the magnitude of the changes in the following variables :

(i) The expansion of acreage
(ii) Irrigation
(iii) Fertilizer
(iv) Improved seed
(v) The control of diseases and insect-pests.

Acreage

At present, about 169 thousand hectares of cultivable waste is there in the State. These data, when plotted on the graph show two district slopes. The fall in culturable waste was rapid during the period 1950-51 to 1962-63 and thereafter the decrease is slow and almost constant. If we assume that the decrease in culturable waste shall follow the trend from 1962-63 onwards during the years to follow, we have the trend for the period 1963-64 through 1968-69 represented by a straight line.

$$Y = 192.4 - 4.6x$$

Where Y refers to the culturable waste acreage in '000 hectares and x refers to time period.

Based on this trend line, the projection of cultural le waste at the end of each plan worked out to be as follows :

	1973-74	1978-79	1983-84
Culturable waste land (000 hectares)	141.8	118.8	95.8
Additional area that comes under the plough (000 hectares)	23.0	23.0	23.0

This gives an estimate of the area that shall come under the plough during this period.

Irrigation

Indian agriculture has remained and shall remain for a considerable time to come to be heavily dependent upon the vagaries of nature. Uncertain rainfall has been the major cause of droughts and floods, causing the failure of agricultural crops in the country. New high-yielding varieties of crops have a higher water requirement and need assured irrigation, without which these varieties cannot be grown successfully. In the Punjab, the net sown area that is irrigated has grown from 53.8% in 1960-61 to 57.3% in 1967-68. The major source of irrigation has been canals, tube-wells and other wells. Whereas the major irrigation schemes (canals) play an important role in providing the irrigational facilities, it is admitted that the entire area of the State cannot be covered by this source. There is, in fact, a very limited scope in the future for increasing the area under canals.

The Punjab has large resources of underground water which is suitable for irrigation except in a few pockets, such as the parts of Bhatinda and Ferozepore districts. There is thus a tremendous scope of increasing tubewell irrigation in the State. It is all the more important to develop tube-well irrigation, because unlike canals it is surer source of irrigation. In the Punjab, large-scale programmes for installing tube-wells are taken up and it is proposed to install 2 lakh additional tube-wells by the end of 1973-74. Presently, some 71,000 tube-wells are in operation. The necessity of such an expansion in tube-well irrigation has been felt because of the increasing requirements of water for the expanding acreage under high-yielding varieties of crops. The number of tube-wells installed went up by about 500 per cent in 1968-69 compared with that in 1960-61. The area irrigated per tube-well, however, decreased. This is an indication of the increase in the intensity of assured irrigation available per acre in the State which is a pre-requisite of the growing of high-yielding varieties. Based on the trend line fitted to the area irrigated by wells as a function of the number of tubewells installed, the following results were obtained :

$$A_t = 763.1066 + .00556\ N_t$$

Where A_t indicates the area irrigated by tubewells in thousand hectares and N_t the number of tube-wells installed. We estimated the area that would receive assured irrigation by tube-wells when 2 lakhs of tubewells, as planned, shall be installed by the end of 1973-74. This worked out at 1,875 thousand hectares (Planned expansion by the State is 1,989 thousand hectares by the end of the Fourth Five-Year Plan. If this is achieved the net area sown in the State that shall be irrigated will go up to 80 per cent of the total net area sown by the end of 1973-74*. With the increase in the net area sown due to cultivable waste that will be put under the plough, the area irrigated shall be about 79 per cent. It is provided in the Fourth Five-Year Plan to make it obligatory on the owner of each tube-well to be installed to carry out soil- and water-management works through the provision of special financing facilities. It is estimated that with this provision alone, it will be possible to irrigate about 25% of the additional acreage through the already existing water resources. There is, therefore, sufficient reason to believe that the irrigation will not work as a restraint on the State agriculture during the period under projection and the whole of irrigable land (by wells and tube-wells) will be commanded by assured irrigation resources after 1973-74.

Fertilizers

Fertilizers constitute another important, rather crucial, input for agricultural production. The consumption of fertilizers in the Punjab State went up from 49,162 tonnes in 1961-62 to 545,256 tonnes in 1968-69. Taking into consideration the area under different crops and the probable area that will come under high-yielding varieties, it has been planned by the State to raise the application targets of nitrogenous fertilizers threefold, phosphatic fertilizers by about eightfold and potassic fertilizers by about twentyfold by the end of the Fourth Five-Year Plan.** Surveys conducted by the Department of Agriculture, Punjab, in 1963-64, have shown that on the average, the farmers use less than 50% of the recommended doses to all the food crops. This poses a problem of diffusion. Since this is an old survey conducted seven years ago, and also that in the following years

*The calculations of the net area irrigated as the percentage of total net area sown have been made on the basis of present figures of the total net area sown (3,992,000 hectares). The total net area sown is, however, likely to increase, as is shown in section on acreage expansion.

**Report on the survey for estimation of area brought under improved agricultural practices, Punjab, 1963-64.

high-yielding crop varieties got developed and profitability of the important crops, such as wheat and paddy, increased, it is quite reasonable to assume that the recommended doses will be applied up to 70% by 1973-74, 80% by 1978-79 and 100% by 1983-84 in the cases of all other crops, because on these crops a low percentage of recommended dose as compared with that on wheat is presently being applied.

Improved Seeds

Surveys in the Punjab[1] have shown that farmers use the recommended quantities of seeds. It is, therefore, assumed that seed will not put any serious restraint on the production programme and in 1973-74 the recommended quantities and qualities of seed will be used by the farmers.

Plant-Protection Practices

The cropping intensity in the State has been on the increase. It has gone up from 117.67 in 1960-61 to 136.30 in 1967-68. It is planned[2] to attain an annual target of seed treatment covering 12.7 lakh hectares under paddy, maize, *bajra*, groundnut, cotton, sugarcane etc. The rat-control measures will be extended to 13.3 lakh hectares, whereas 12 lakh hectares will be covered for the control of various pests in the areas that get affected seriously *en bloc*.

All these measures shall get a long way in increasing the yields of crops per hectare. Main effect that shall account for the raising of foodgrain production shall then be through:

(i) The raising of the yield per acre
(ii) Multiple-cropping
(iii) An increase in the cultivated area

Production of Various Crops

To project the production of different crops we have made some assumptions that sound reasonable under the set of conditions already explained. Projections here are made at three different levels corresponding to different sets of assumptions at each level.

Case I : This may be taken as a very conservative estimate. It has been assumed here :

1. Report on the Survey for estimation of area brought under improved agricultural practices, Punjab, 1963-64.
2. Draft outline of the Fourth Five-Year Plan, Punjab.

1. That the total area under crop will not change over the projection period and only the distribution of this area under high-yielding varieties and local varieties will change.

2. That the level of inputs (fertilizer, seed, etc.) will not change during this period and will remain at the current level. This implies that the average yield of the high-yielding varieties and the local varieties will remain constant during this period.

Case II : The first two assumptions have been allowed to relax. It has been assumed :

1. That area under crops will grow and this increase will be possible only through the reduction in the culturable waste. The area that goes to each crop from this reclaimed land will bear the same ratio as it is to the existing net sown area in the State.

2. That the level of fertilizer application shall also change during this period. It has been assumed that the level of application shall change, as already explained earlier.

Case III (wheat only) : The use of fertilizers and the expansion of cultivated acreage remaining the same, as in the case of II, an additional assumption made here is that the entire area under the gram crop, which competes with wheat, will be put under wheat, as it comes under the assured irrigation.

With these assumptions, we proceed to project the production of each crop.

Wheat: During 1968-69, the area under wheat was estimated at 2,063 thousand hectares, of which 1,194 thousand hectares (about 60%) was under the high-yielding varieties (Table 6.10) and the rest, i.e. 869 thousand hectares under local varieties. Of the total area under wheat, more than 70 per cent was irrigated. It is envisaged that by the end of the Fourth Five-Year Plan, the area under the high-yielding varieties will be as much as 1,418 thousand hectares* (roughly 70%) out of the total area under wheat that was supposed to move to 2,000 thousand hectares. Since the present area under wheat is more than what is envisaged to be at the end of the Fourth Five-Year Plan, we have assumed that the area under the high-yielding

*Target set in the Fourth Five-Year Plan of the Punjab.

varieties will be 70% of the present area and will grow to 85% at the end of the Fifth Plan and to 95 per cent at the end of the Sixth Plan, leaving a margin of 5 per cent to other varieties.

Average yield. Farm-management surveys being conducted in the Ferozepore District recorded the following average yields (quintals per hectare) for the Mexican varieties and the local varieties for two years.

Year	*Mexican*	*Local*
1967-68	29.92	18.75
1968-69	22.46	13.64
Average	26.19	16.18

The ratio between the Mexican and the *desi* varieties range between 160:100 and 165:100. This shows that on the average, the Mexican varieties yield 60 to 65 per cent more than the local. The average yields of the State has been estimated at 21.77 quintals per hectare. This includes both the new high-yielding and the local varieties. Knowing the area under the high-yielding and the local varieties, we apportioned this yield into the Mexican and the local in such a way that it bore the ratio 162.25:100.*

Using this method, the yields worked out to be 26 quintals per hectare of the Mexican and 10 quintals per hectare of the *desi*. Under the assumption of constant technology, the average yield for the State was thus taken to be 26 and 16 quintals per hectare for the period under projection. Holding the input use constant, as assumed under the case I, the production projection worked out to be as shown in Table 6.10.

Under these conservative assumptions, as in case I the production of wheat will increase to 4744.8 thousand tonnes by the end of Fourth Five-Year Plan, 5053.8 thousand tonnes by the end of the Fifth Five-Year Plan to 5260.6 thousand tonnes by the end of Sixth Plan.

Case II. In this case, the first assumption of case I, has been relaxed and the area under wheat is assumed to increase exclusively owing to the decrease in the culturable waste during the period under projection.

---

*This is done as follows : Let the yield be 162.25x and 100x for Mexican and the *desi* respectively. Then

$$\frac{162.25x(\text{area under H.Y.V.}) + 100x(\text{area under desi})}{\text{Total area}} = \text{Yield}$$

The solution gives the value of x and hence the yield of the Mexican and the desi bearing the given ratio.

TABLE 6.10

The projected production of wheat in the Punjab (*Case I*)

	1968-69	1973-74	1978-79	1983-84
Area under wheat (000 ha.)	2063	2063	2063	2063
Area under high-yielding varieties (000 ha.)	1194	1444	1753	1960
Area under local varieties (000 ha.)	869	619	310	103
Average yield of high-yielding varieties (q./ha.)	26	26	26	26
Average yield of local varieties (q./ha.)	16	16	16	16
Fertilizer level	Same as is being used at present			
Production (000 tonnes)	4494.8	4744.8	5053.8	5260

Out of this additional area that comes under the plough, the area devoted to the wheat crop will grow in the proportion that wheat bears to the net area sown at present. The area under wheat as a percentage of the net area sown comes to 44.83 in 1967-68. (Appendix IV). We, therefore, apportion 45 per cent of the reclaimed land to the wheat crop. The area under the wheat crop will, thus, grow as shown in Table 6.11.

TABLE 6.11

The projected production of wheat in the Punjab (*Case II*)

	1968-69	1973-74	1978-79	1983-84
Area under wheat (000 ha.)	2063	2073.35	2083.70	2094.05
Area under high-yielding varieties (000 ha.)	1194	1451.34	1771.14	1989.35
Area under local varieties (000 ha.)	809	622.01	312.56	104.70
Average yield of high-yielding varieties (q./ha.)	26	39.0	40.5	42.0
Average yield of local varieties (q./ha.)	16	17.0	18.0	18.0
Fertilizers level (%)	50	70	80	100
Production (000 tonnes)	4494.8	6717.6	7735.7	8543.7

The second assumption of constant technology has been relaxed. It has been assumed that during this period, a higher percentage of fertilizer will be used. As already mentioned, a survey by the Department of Agriculture has shown that the farmers used less than 50% of the recommended dose. Hence, we assume that its use will go up to 70, 80 and 90 per cent of the recommendations in three projected periods. Taking the recommended dose of 120 kg. per hectare to be the optimum for the Mexican wheat, the corresponding yields have been obtained by using the production function for the wheat crop for the Punjab.

$$Y = 2209 + 29.01\ N = .101\ N^2 *$$

The yield of the local wheat has been kept maximum at 18 quintals per hectare. The production estimates in case II, thus, worked out are shown in Table 6.11. The production under these assumptions, thus, will increase to 6717.6, 7735.7 and 8543.7 thousand tonnes by the end of the fourth, fifth and sixth plans respectively.

Case III. The level of fertilizers and other inputs remaining the same as in case II and the additional assumption made here is that the area under gram will be replaced by wheat on the additional acreage brought under irrigation. It can be seen that the area under gram is decreasing steadily (Appendix V). We have assumed the decline to continue at the same rate. We further assume that the area released from this crop will go to wheat. The decline in the area under gram seems to be occurring at a constant rate and, as such, the straight line fitted to this data works out to be

$$Y = 946.89 - 49.06\ t$$

Projecting the decline with the help of this equation, the additional area that will go to wheat will be as under :

	1973-74	1978-79	1983-84
Area transferred to the wheat crop from gram (000 hectares)	270	515	530

Under these assumptions, the production has been estimated, as shown in Table 6.12.

TABLE 6.12

The projected production of wheat in the Punjab (*Case III*)

	1968-69	1973-74	1978-79	1983-84
Area under wheat (000 ha.)	2063	2343.35	2598.70	2624.05
Area under high-yielding varieties (000 ha.)	1194	1640.35	2208.89	2492.85
Area under local varieties (000 ha.)	896	703.00	389.81	131.20
Average yield of high-yielding varieties (q./ha.)	26	39.00	40.5	42.0
Average yield of local varieties (q./ha.)	16	17.0	18.0	18.0
Fertilizer level (%)	<50	70	80	100
Production (000 tonnes)	4494.8	7592.46	9647.62	10706.03

In this case, the production of wheat will increase to 7592.46, 9647.62 and 10706.03 thousand tonnes at the end of Fourth, Fifth and Sixth Plans.

*Based on the All-India Co-ordinated Wheat Trials.

Paddy: The area under paddy in the State has been estimated at 345 thousand hectares in 1968-69, of which only 26.30 thousand hectares was under the improved (high-yielding) varieties and the rest under the local varieties. The area under high-yielding varieties forms only 7.62 per cent of the total area under paddy. It has been envisaged to bring 142 thousand hectares under the high-yielding varieties of paddy by the end of the Fourth Plan. This constitutes 40% of the present area under paddy with the higher yield potential of newly released paddy varieties. The area under high-yielding varieties of paddy is assumed to go up to 75% and 90% by the end of 1978-79 and 1983-84. Once the rate of adoption has accelerated, it will be higher in the beginning, but will slow down at a later stage. Another encouraging feature is that the high-yielding varieties of paddy require less water than the local ones. Almost about 90 per cent of the paddy area is already irrigated. As such, there seems to be no reasons for the farmers not going in for the new high-yielding varieties. In our estimates of the shift to high-yielding varieties, we have left a margin of 10 per cent of the area for the fine varieties that command a higher price.

The high-yielding varieties of paddy yield about 50 to 60 per cent more than the local ones and as such we have assumed a ratio of 150:100 in this case for apportioning the present yield (in terms of husked paddy) in the State, i.e. 13.64 quintals per hectare to the high-yielding and the local varieties. The present average yield of the high-yielding varieties of paddy works out at 20.80 quintals per hectare and that of the local varieties 13.60 quintals per hectare.

In Case I, the production works out to be as shown in Table 6.13.

TABLE 6.13

The projected production of paddy (rice) in the Punjab (*Case I*)

	1968-69	1973-74	1978-79	1983-84
Area under paddy (000 ha.)	345.00	345	345	345
Adoption level for high-yielding varieties (%)	7.62	40	75	90
Area under high-yielding varieties (000 ha.)	26.30	142	258	310
Area under local varieties (000 ha.)	318.70	203	87	35
Average yield of high-yielding varieties (q./ha.)	20.80	20.8	20.8	20.8
Average yield of local varieties (q./ha.)	13.60	13.60	13.60	13.60
Fertilizer level	Same as in the base year			
Production (000 tonnes)	488.14	571.44	654.96	692.40

The production would thus increase to 571.44, 654.96 and 692.40 thousand tonnes by 1973-74, 1978-79 and 1983-84 respectively.

Case II. The area under paddy is assumed to increase in consequence of the reduction in the area of the culturable waste. This crop bears a ratio of .08:1 to the net sown allocated to the paddy crop.

Again, so far as the yield is concerned, it has been assumed that the farmers will move to the present optimum level* of fertilizer use by 1983-84. The optimum yields have been worked out from the following production functions:**

$Y_h = 1423.388 + 31.080\ N - .106\ N^2$
$Y_l = 1067.900 + 22.160\ N - .100\ N^2$
Y_h refers to the yield of high-yielding varieties in lb. per acre.
Y_l refers to the yield of the local variety in lb. per acre.

The production of rice in the State thus worked out, is shown in Table 6.14.

TABLE 6.14

The projected production of rice in the Punjab (*Case II*)

	1968-69	1973-74	1978-79	1983-84
Area under paddy (000 ha.)	345.00	346.84	348.69	350.52
Area under high-yielding varieties (000 ha.)	26.30	142	261.51	315.47
Area under local varieties (000 ha.)	318.70	204.84	87.17	35.05
Average yield of high-yielding varieties (q./ha)	20.80	32.74	37.74	40.75
Average yield of local varieties (q./ha.)	13.60	18.40	20.68	22.82
Fertilizer level (%)	50	75	100	
Production (000 tonnes)	488.14	841.81	1167.20	1365.52

The production of the rice under Case II, thus, moves to 841.81, 1167.20 and 1365 thousand tonnes by the end of 1973-74, 1978-79 and 1983-84 respectively.

Maize: Area under maize in the State has been estimated at 490 thousand hectares in 1968-69. Out of this, 48.18 thousand hectares was under hybrid and 441.88 under the local varieties. The hybrid maize was grown on 10 per cent of the area. It is envisaged to cover 20 per cent of the area by the end of the Fourth Five-Year Plan***. This crop is considered to be highly

*It has been assumed that the present optimum technology will remain unchanged during this period.
**Based on All-India Co-ordinated Trials for High-Yielding Varieties. 1966-67.
***Draft Fourth Five-Year Plan of Punjab.

uncertain, because of its late maturity and pest attack. Farmers feel a little hesitant to grow this crop. Owing to the new varieties of wheat that can be sown as late as the end of November, the problem of late maturity is, however, supposed to fade away. It is hoped that farmers shall start growing the crop in a larger area. Hence, it is asssumed that 20 per cent, 40 per cent and 60 per cent of the area under maize will be covered by the hybrid/composite maize by the end of the Fourth, Fifth and Sixth Plans. Under the assumption of constant technology and fertilizer use, the present yield of 14.40 quintals per hectare has been apportioned to the hybrid maize and to the *desi* maize in the proportion of 125:100. The hybrid maize, on an average, yields 20 to 25 per cent more than the local one. The present yield thus works out at 17.58 quintals per hectare for the hybrid/composite maize and 14.06 quintals per hectare for the *desi* maize. With these assumptions, the production of maize worked out at 723.43, 757.93 and 792.42 thousand tonnes by the end of the Fourth, Fifth and Sixth Plans (Table 6.15).

TABLE 6.15

The projected production of maize in the Punjab (*Case I*)

	1968-69	1973-74	1978-79	1983-84
Area under maize (000 ha.)	490.00	490.00	490.00	490.00
Area under high yielding varieties (000 ha.)	48.18	98.00	196.00	294.00
Area under local varieties (000 ha.)	441.82	392.00	294.00	196.00
Average yield of high yielding varieties (q./ha.)	17.58	17.58	17.58	17.58
Average yield of local varieties (q./ha.)	14.06	14.06	14.06	14.06
Fertilizer level	Same level as at present			
Production (000 tonnes)	705.90	723.43	757.93	792.42

Case II. The maize crop covers 12 per cent of the net area sown in the State and, as such, 12 per cent of the additional area from the reclaimed culturable wasteland has been apportioned to this crop. The area under this crop increases, as shown in Table 6.16.

TABLE 6.16

The projected production of maize in the Punjab (*Case II*)

	1968-69	1973-74	1978-79	1983-84
Area under maize (000 ha,)	490.00	492.76	495.52	498.28
Area under high-yielding varieties (000 ha.)	48.10	103.05	198.20	298.96
Area under local varieties (000 ha.)	441.82	389.71	297.32	199.32
Average yield of high-yielding varieties (q./ha.)	17.58	31.88	35.68	40.50
Average yield of local varieties (q./ha.)	14.06	23.13	25.71	29.64
Fertilizer level (%)		50	75	100
Production (000 tonnes)	705.90	1229.92	1471.58	1801.57

Again, it has been assumed that the farmers will gradually move towards the use of the optimum dose of the fertilizers by the end of 1983-84. The optimum works out at 40.50 kg. for the hybrid maize and 29.64 kg. for the local maize. This is based on the production of functions.

Y_h*$=2201+18.97\ N-.042\ N^2$

$Y_l=1899+14.14\ N-.037\ N^2$

Y_h stands for yield in kg. per hectare of the hybrid

Y_l stands for yield in kg. per hectare of the local.

The yields on the assumption of 50 and 75 per cent of the recommended dose of the fertilizer use have been worked out for 1973-74 and 1978-79. Based on these assumptions, the projections of maize production work out at 1229.92, 1471.58 and 1801.57 thousand tonnes at the end of the Fourth, Fifth and Sixth Plan (Table 6.16).

Bajra: The area under *bajra* in the State has been estimated at 193 thousand hectares in 1968-69. It is less by 16 thousand hectares than that in 1967-68. This decrease can be ascribed to the attack of ergot. The hybrid *bajra* covered an area of 81 thousand hectares in 1968-69 which forms 42% of the total area. It has been proposed to cover 60 per cent of the area under the hybrid *bajra* during the Fourth Five-Year Plan. We have assumed the area to remain the same as in 1967-68, i.e. 209 thousand hectares, and it is assumed that out of this area, 60 per cent will be covered by the hybrid *bajra* by the end of the Fourth Five-Year Plan, about 75% by the Fifth Plan and 90% by the end of the Sixth Plan. The rest is assumed to remain under the local *bajra* or fodder crops.

The present yield of the *bajra* crop has been estimated at 10.55 quintals per hectare. This yield has been divided into 150:100 ratio, knowing the area under the hybrid and the local *bajra*. This ratio has been worked out on the basis of the experimental yield of these varieties. Under the assumption of constant technology, the yields of two varieties have been assumed to remain unchanged during the period under study. Hence, the production of this crop works out at 236.38, 241.32 and 263.65 thousand tonnes at the end of the Fourth, Fifth and Sixth Plans in Case I (Table 6.17).

*Based on All-India Co-ordinated Trials on Hybrid Maize.

TABLE 6.17

The projected production of *bajra* in the Punjab (*Case I*)

	1968-69	1973-74	1978-79	1983-84
Area under *bajra* (000 ha.)	193.00	209.00	209.00	209.00
Area under high-yielding varieties (000 ha.)	81.00	125.40	156.75	188.10
Area under local varieties (000 ha.)	112.00	83.60	42.25	20.90
Average yield of high-yielding varieties (q./ha.)	13.05	13.05	13.05	13.05
Average yield of local varieties (q./ha.)	8.70	8.70	8.70	8.70
Fertilizer level	Same as in the base year			
Production (000 tonnes)	203.15	236.38	241.32	263.65

Case II. The area under *bajra* is 5.2% of the net area sown in the State. Out of the reclaimed area from culturable waste, 6% has been apportioned to this crop. The area under *bajra* is then assumed to grow as in Table 6.18.

TABLE 6.18

The projected production of *bajra* in the Punjab (*Case II*)

	1968-69	1973-74	1978-79	1983-84
Area under *bajra* (000 ha.)	193.00	210.38	211.76	213.14
Area under high-yielding varieties (000 ha.)	81.00	126.22	158.82	191.82
Area under local varieties (000 ha.)	112.00	84.16	52.94	21.32
Average yield of high-yielding varieties (q./ha.)	13.05	26.00	29.97	33.09
Average yield of local varieties (q./ha.)	8.70	16.99	19.59	21.58
Fertilizer level (%)	50	50	75	100
Production (000 tonnes)	203.15	471.16	579.69	680.74

The yield level is assumed to grow steadily towards the optimum by the end of 1983-84. Based on the production function

$$Y_h = 13.74 + .2524\ N - .0008\ N^2$$

The optimum works out at 33.09 quintals per hectare in the case of hybrid *bajra*. Since the data on the local *bajra* was not available, no production function could be fitted to this variety. It is assumed to bear the same ratio of 150:100 throughout. Based on this ratio, the yield of the local *bajra* has been obtained through the yield of the hybrid *bajra*.

Under these assumptions, the production of *bajra* works out at 471.16, 579.69 and 680.74 thousand tonnes by the end of the Fourth, Fifth and Sixth Plans (Table 6.18).

Pulses: The figures show that the area under pulses has been continuously declining during the period 1950-51 through 1968-69. This decline has been mainly in the gram crop. We have taken this crop into consideration and have allocated its area to the wheat crop under the assumption that irrigation facilities will increase. The area under other pulses has been steady, which, of course, is negligible percentage and, hence, does not contribute much to foodgrain production. This area can in future shift to *bajra* or maize, depending upon the soil conditions of different areas. We have, however, ignored these crops as such.

Table 6.19 gives a consolidated picture of the estimated production of foodgrains, as it would be at the end of each plan period. The total foodgrains production in the Punjab under Case I will move to 6276.0, 6707.9 and 7009.0 thousand tonnes by the end of Fourth, Fifth and Sixth Plans.

TABLE 6.19

The estimated production at the end of three plans, 1968-69 through 1983-84

Crops	1968-69	1973-74	1978-79	1983-84
Case I				
Wheat	4494.8	4744.8	5053.8	5260.6
Maize	705.9	723.4	757.9	792.4
Rice	488.1	571.4	654.9	692.4
Bajra	203.1	236.4	241.3	263.6
Total	5891.9	6276.0	6707.9	7009.0
Case II				
Wheat	4494.8	6717.6	7735.7	8543.7
Maize	705.9	1229.9	1471.5	1801.6
Rice	488.1	841.8	1167.2	1365.5
Bajra	203.1	471.1	579.7	680.7
Total	5891.9	9260.4	10954.1	12391.5
Case III				
Wheat	4494.8	7592.4	9647.6	10706.0
Maize	705.9	1229.9	1471.5	1801.5
Rice	488.1	841.8	1167.2	1365.5
Bajra	203.1	471.1	597.7	680.7
Total	5891.9	10135.2	12866.0	14553.7

In Case II, the foodgrain production should be 9260.4, 10954.1 and 12391.5 thousand tonnes by the end of the plan periods. In case III, which is more comprehensive and involves all the important related changes, the production of the food crops should move to 10135.2, 12866.0 and 14553.7 thousand tonnes by the end of the plans.

Marketable Surpluses

In the first section, we projected the State consumption demand of some selected agricultural commodities under three different situations, each situation characterizing different assumptions regarding the population growth in the State. As worked out in section I, Table 6.20 below gives the total foodgrain consumption in the Punjab, as it would be at the end of the Fourth, Fifth and Sixth Plans. The total demand for foodgrains include human and non-human consumption.

TABLE 6.20

The estimated total foodgrains demand for consumption in the State through three plan periods

Year	Total demand (000 tonnes)		
	Situation I	Situation II	Situation III
1968-69 ..	2569.95	2569.95	2584.95
1973-74 ..	3126.48	3126.48	3263.93
1978-79 ..	3680.50	3725.06	3984.78
1983-84 ..	4339.54	4552.25	4750.28

The supply of foograins in the Punjab has also been worked out at three different levels. Even at the most conservative estimates, that is, when everything remains the same, only the distribution of the area under foodgrain crops changes in favour of the high-yielding varieties and then there emerges a surplus. If we compare the demand in situation III with the supply in case I, we get the following annual surpluses in foodgrains at the end of three plan periods.

Year	Demand (000 tonnes)	Supply (000 tonnes)	Surplus (000 tonnes)
1968-69 ..	2584.95	5891.90	3306.95
1973-74 ..	3263.93	6276.00	3012.07
1978-79 ..	3964.78	6707.90	2723.12
1983-84	4750.28	7009.00	2248.72

This shows that if the technology remains static, i.e. input per acre does not change, these surpluses would go on diminishing in the future. But if the technology changes and other changes occur, as we assume in situations II and III, the foodgrain surpluses against demand conditions of situation III work out as under :

	Surpluses	
	Supply situation II (000 tonnes)	Supply situation III (000 tonnes)
1968-69	3306.95	3306.95
1973-74	5996.47	6871.27
1978-79	6969.32	6881.22
1983-84	7641.22	9803.42

With the changing technology and input use, the Punjab State is thus likely to produce the ever-increasing foodgrain surpluses to the tune of 6,871,000 tonnes by the end of the Fourth Plan, 6,881,000 tonnes by the end of Fifth Plan and 9,803,000 tonnes by the end of the Sixth Plan.

Appendix I

Aggregate projected demand for various food items in rural and urban sectors of Punjab (000 tonnes)

SITUATION I

Item	1964-65		1968-69		1973-74		1978-79		1983-84	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Rice	98.11	18.77	106.73	20.95	122.86	24.74	141.36	30.72	164.05	38.83
Wheat	1258.85	364.51	1432.86	406.86	1785.84	486.36	2120.18	611.91	2413.50	786.43
Maize	220.57	41.67	236.08	44.68	264.61	48.59	293.33	50.11	317.93	48.07
Total cereals	1620.48	430.56	1859.88	476.44	2254.22	562.43	2565.31	691.77	2901.37	872.15
Pulses	114.65	32.35	129.26	35.98	159.25	43.19	185.86	54.28	265.81	67.75
Foodgrains	1735.04	463.00	1989.15	512.41	2413.50	605.60	2751.18	746.04	3167.18	939.90
Fruits and vegetables	245.82	112.74	296.53	134.03	399.50	174.78	566.82	248.34	839.14	361.94
Milk and milk products	650.40	154.32	817.28	198.88	1166.26	278.42	1741.76	449.00	2715.48	715.68

APPENDIX II

Aggregate projected demand for various food items in rural and urban sectors of Punjab (000 tonnes)

SITUATION II

Item	1964-65		1968-69		1973-74		1978-79		1983-84	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Rice	98.11	18.77	106.73	20.95	122.86	24.74	141.95	30.85	165.53	39.27
Wheat	1258.85	364.51	1432.86	406.86	1785.84	486.36	2164.48	614.56	2500.57	791.24
Maize	220.57	41.67	236.08	44.68	264.61	48.59	293.68	50.44	322.74	49.38
Total cereals	1620.47	430.56	1859.88	476.44	2254.22	562.43	2588.90	707.62	3059.15	899.33
Pulses	114.65	32.35	129.26	35.98	159.25	43.19	202.12	54.44	266.29	76.42
Foodgrains	1735.04	463.00	1989.15	512.41	2413.50	605.60	2791.04	762.14	3325.43	975.79
Fruits and vegetables	245.82	112.74	296.55	134.03	399.50	174.78	566.23	248.40	839.42	362.14
Milk and milk products	650.40	154.32	817.28	198.88	1166.26	278.42	1740.38	447.94	2726.94	713.06

APPENDIX III

Aggregate projected demand for various food items in rural and urban sectors of Punjab (000 tonnes)

SITUATION III

Item	1964-65		1968-69		1973-74		1978-79		1983-84	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Rice	98.44	18.80	107.54	21.10	124.28	25.00	144.20	31.36	169.20	39.60
Wheat	1263.49	365.87	1441.04	409.48	1800.12	496.68	2332.68	620.88	2676.54	802.18
Maize	222.38	42.78	225.78	45.01	267.61	48.71	299.47	47.56	331.19	50.99
Total cereals	1626.38	432.22	1868.81	481.15	2361.49	579.08	2810.88	715.48	3219.30	911.38
Pulses	115.07	32.41	130.20	36.24	159.84	44.16	203.81	54.88	276.99	71.41
Foodgrains	1741.40	464.68	2001.02	515.38	2521.18	623.30	3014.71	770.38	3482.08	996.76
Fruits and vegetables	246.72	113.28	297.52	134.59	401.53	178.91	567.54	249.30	842.38	363.62
Milk and milk products	652.70	154.90	819.70	199.58	1167.77	292.27	1741.93	447.95	2738.92	712.76

APPENDIX IV

Area under different crops as per cent of net cropped area

Year	New sown area	Wheat	%	Rice	%	Maize	%	*Bajra*	%
1960-61	3750	1394	37.2	228	6.1	326	8.7	124	3.3
1961-62	3826	1433	37.4	228	6.0	323	8.4	142	3.7
1962-63	3833	1516	39.5	249	6.5	362	9.4	136	3.5
1963-64	3855	1510	39.2	257	6.7	354	9.2	105	2.7
1964-65	3895	1563	40.1	287	7.4	383	9.8	160	4.1
1965-66	3796	1548	40.8	293	7.7	385	10.1	156	4.1
1966-67	3886	1608	41.4	285	7.3	444	11.4	184	4.7
1967-68	3992	1790	44.8	314	7.9	476	11.9	209	5.2
For projected years (assumed)			45.0		8.0		12.0		6.0

APPENDIX V

Area under different crops and the percentage area irrigated in the Punjab, 1960-61 through 1968-69

Year	Wheat		Rice		Maize		*Bajra*		Gram	
	Area 000 ha.)	Percentage irrigated	Area (000 ha.)	Percentage irrigated	Area (000 ha.)	Percentage irrigated	Area (000 ha.)	Percentage irrigated	Area (000 ha.)	Percentage irrigated
1960-61	1394	57.4	228	81.1	326	64.1	124	38.7	871	27.3
1961-62	1433	58.5	228	78.1	323	61.6	142	33.8	849	28.5
1962-63	1516	57.7	249	80.3	362	64.6	136	38.2	817	28.9
1963-64	1510	62.1	257	82.9	354	62.1	105	35.2	761	27.1
1964-65	1563	62.9	287	81.9	383	64.0	160	35.0	744	29.9
1965-66	1548	68.2	293	86.3	384	68.3	156	34.0	603	34.4
1966-67	1608	72.1	285	85.6	444	66.9	184	40.8	634	34.5
1967-68	1790	70.5	314	81.8	476	67.0	209	43.5	530	35.1

CHAPTER VII

THE DYNAMICS OF FOODGRAIN MARKET STRUCTURE IN THE PUNJAB

During the past decade and a half, development economists have shown a growing recognition of the positive relationship and interaction between the goals of development planning, on the one hand, and the structure, conduct and performance of the marketing system, on the other. Marketing efficiency arises from the efficient use of resource in that sector, without which wasteful problems of marketing costs and handling develop in the process of creating time, form and place utility of the products. In addition, the commodity prices, which perform the functions of resources allocation, intersectoral income distribution, and capital formation, are generated within the framework of the marketing system. Unless a market structure has the forces conducive to the generation of an efficient process of pricing, the three functions of price would be inefficiently performed. Production plans, in consequence, might receive a set-back.

Thus the existence of an efficient marketing system is an important element in the development process. It is, therefore, important to know whether the functioning of agricultural markets is in accordance with the socially and economically accepted norms of efficiency within the constraints of the given level of technology. The causes of inefficiency should be determined, and the possibility for effecting institutional as well as technological changes that might lead to increased physical and economic efficiency should be explored. Also, sharp increases due to technological innovations occur in the total volume of production. Consequently, increases in the volume of marketed surplus are expected. It is important to know whether the present institutional and functional organisation can adjust itself to the increased demand for marketing services and can also determine the direction and magnitude of the required resource allocation by the public sector to the marketing improvement programmes. The following pages, therefore, review the present set-up and organization of the marketing system, and lay special emphasis on the problems emerging from the increased marketed surplus and hint at their solutions.

During the last two decades, the technology has been changing in the Punjab. To start with, the change was slow, but it

gathered momentum with the release of the new varieties of crops, specially of wheat. The change in the technology since then (1966-67) has been pretty fast. Accordingly, this review of production and marketing arrangements have been divided into two periods, viz. (1) the period of slow development and (2) the period of fast development.

The Period of Slow Development (1960-61 to 1965-66)

Table 7.1 shows the production of foodgrains in the Punjab from 1960-61 to 1969-70. It is evident from the Table that till 1965-66, the foodgrain production maintained an unsteady and slow upward trend. The foodgrain production during 1965-66 increased by only 4.83 per cent over the average of 1960-61 and 1961-62. Since the production during this period was low and the yearly increase was only marginal, the marketable surplus with the farmers generally remained low. The majority of the producers, being poor, had no staying power and sold their produce in the post-harvest season. This resulted in relatively wider seasonal fluctuations. Consequently, the marketing margins were relatively wider during 1960-61 to 1965-66.

TABLE 7.1

The production of foodgrains in the Punjab, 1960-61 to 1969-70

Year	Production (000 tonnes)	Percentage increase (+) over or decrease (—) from the previous year	Percentage increase (+) over or decrease (—) from the averages of 1960-61 and 1961-62
1960-61	3162	..	..
1961-62	3304	+4.49	..
1962-63	3058	—7.45	—5.41
1963-64	3243	+6.05	+0.31
1964-65	4028	+24.21	+24.21
1965-66	3389	—15.86	+4.83
1966-67	4178	+23.28	+29.23
1967-68	5368	+28.48	+66.04
1968-69	6212	+15.72	+92.04
1969-70	6968	+12.17	+115.53

Source : Statistical Abstract of Punjab, 1970.

The volume of arrivals to be handled in the foodgrains market in the post-harvest seasons being small, it was generally manageable with manual labour. Operations connected with the physical handling of foodgrains, viz. cleaning, weighing, loading and unloading, were performed with manual labour and finished by the evening every day.

The producers returned to their homes the same day after the sale of their produce. The lifting of the stocks was done by bullock-carts and no difficulty was experienced in performing this function.

The traders had their own stores, and sometimes the Government would hire their godowns for stocking the imported or locally procured wheat. The Government or other public bodies had only very meagre storage capacity of their own. The unscientific storage at the traders' hand resulted in storage losses which varied from 3 to 15 per cent.[1]

As mentioned earlier, the prices of foodgrains generally moved upwards from the post-harvest to the lean periods and the Government had to distribute foodgrains throguh fair-price shops, so as to check the soaring prices during the lean periods. Whenever the government needed to procure the foodgrains, it was done either by acquiring the traders' stocks or by forcing traders to keep the prices at a low level, thus stopping the operation of the forces of the free market leading to the pricing inefficiency. Otherwise, the traders would compete with the Government for purchases and prices would go high beyond the Government capacity to purchase. The Government maintained only small establishment to supervise some market operations and distribute the controlled articles, including foodgrains and other consumer goods. The marketing finance for the trade was partly supplied by the banks and partly from private funds.

It is, thus, apparent that, although most of the marketing operations were performed through human labour or animal power, yet there was no strain on the marketing system to handle the marketed surplus even during the post-harvest seasons. However, the technological improvement was not there, as evidenced by the higher costs and wider margins. Thus the existing market structure led to poor market conduct[1] and performance due to the inaccessibility of the market areas, the lack of grading and standardization, the non-availability of scientific storage capacity, etc.

The Period of Fast Development (1966-67 to 1969-70)

Table 7.1 shows that the production of foodgrains in the Punjab during 1966-67 to 1969-70 showed a rapid increase year after year. The 1969-70 production increased by 115.53 per cent over the averages of 1960-61 and 1961-62. This increase was due to the fast developments in the farming technology.

1. Kahlon, A.S. 1970. Impact of Changing Conditions on Grain Marketing Institutions and the Structure of Grain Markets in the Erstwhile Punjab. Punjab Agricultural University, Ludhiana. p. 62

The increased production of foodgrains, coupled with Government procurement and price policy showed a spectacular increase in the market arrivals. Table 7.2 provides a comparison of the production and the marketed surplus of wheat during 1966-67 to 1970-71. As the production during a year is marketed in the following year, the production for 1966-67 through 1969-70 is compared with the arrivals of 1967-68 through 1970-71 respectively.

TABLE 7.2

The production and marketed surplus of wheat in the Punjab, 1966-67 to 1970-71

Year	Production (lakh tonnes)	Percentage increase over the previous year	Arrivals (lakh tonnes)	Percentage increase over the previous year	Per cent of production received in the market
1966-67	24.5	..	..	..	..
1967-68	33.4	36.3	8.2	..	33.46
1968-69	44.9	34.4	16.4	100.0	49.10
1969-70	49.2	9.6	23.2	41.5	51.67
1970-71	..	..	28.0	20.7	56.91

As the Punjab was already a surplus State, the percentage increase in the marketed surplus was much higher than the production. It is evident from Table 7.2 that during 1968-69, the production of wheat increased by 34.4 per cent over that during the previous year, whereas the increase in the market arrivals was 100 per cent during the same period.

Similarly, against an increase of 9.6 per cent in production during 1969-70, the market arrivals increased by 41.5 per cent. Thus the marketed surplus increased by about 250 per cent by 1970-71 as compared with that of 1966-67 against an increase of about 100 per cent in production. Such a tremendous increase put the existing marketing facilities out of gear and posed many marketing problems, demanding the necessary changes in the structure of the wheat market. The main market problems emerging from the spurt in production and increased market arrivals based on a recent study[1] are summarized below :

Capacity of the Market Yards

One of the most important problems emerging from the recent breakthrough in production is the inadequacy of the existing market yards to accommodate the increased wheat arrivals. Dur-

[1]Gill, K.S. 1971. Wheat Market Behaviour in Punjab and Haryana, Post-Harvest Period 1968-69 through 1970-71. P.A.U., Ludhiana.

ing the post-harvest peak days, no space was left for unloading the arrivals in the market yards and the transactions were held in the lands and sub-urban lands which were muddy and gave no protection against rains. This led to the wastage of the produce and caused great inconvenience to the farmers, traders, labourers and public agencies who had to work in the scorching heat and in the rains.

Again, in the congested urban market yards, like those of Ludhiana, the gluts in the markets were very serious and the traffic jam continued for hours together. After experiencing these situations, the market yards from congested market were moved to the outskirts of the cities. The temporary market, yards, being *kacha*, the produce got mixed with dust and dirt, and during the rains, the yards were flooded and rendered unserviceable. Further, the public agencies had to make duplicate arrangements, i.e., at the permanent yards and at the temporary yards, to take care of this problem. Similarly, the traders had to run their shops at two places, thus leading to the duplication of costs and creating a source of confusion for the producers.

The Number of Procurement Centres

To reduce the pressure on established markets and to lessen the severity of the serious gluts, the Government increased the number of procurement centres. The number of procurement centres in the Punjab increased from 121 during 1967-68 to 223 during 1970-71. But these newly opened procurement centres lacked the basic marketing facilities, like raised and covered auction platforms for unloading the produce and to protect it against rains.

Market Labour

The increased volume of the marketed surplus, created yet another serious bottleneck in the handling of the produce. The labourers could not cope with the volume of business and they could not attend to their functions properly. For example, while stitching the wheat bags, they would stitch them at only 7-10 places instead of at 14-16 places usually. Similarly, the stocks in the market lay unlifted for days together and this thing aggravated the glut conditions. The increased number of labourers were employed in the market to alleviate the situation, as given in Table 7.3.

It may be seen that the number of carts and labourers increased by more than 100 per cent during the past four years,

TABLE 7.3

The numbers of contractors, labourers and carts in Ludhiana, Khanna and Doraha markets

Post-harvest seasons	The number of contractors	The number of labourers	The numbers of carts for lifting the produce
1967-68	12	291	58
1968-69	12	469	71
1969-70	13	565	98
1970-71	10	600	122

so as to cope with the increasing marketed surplus. Recently, trucks were frequently used whenever there was rush to lift the produce from the markets to the local godowns or to the railway stations.

The Cleaning of Produce

Before 1966-67, wheat was cleaned by manual labour with winnowing-pans (*chhajj*) made of reeds. The labour could not cope with the volume of business, and the cleaning operation consumed a lot of time. This necessitated the use of large sieves fixed in wooden frames having one wire-mesh. But this type of sieves could not clean the wheat adequately and left the foreign matter up to 2.15 per cent in the stocks. In some markets, semi-mechanized cleaners were introduced and they cleaned the produce satisfactorily.

Grading and Standardization

The functions of selling, transportation, storage, etc. can be performed more efficiently if a product apportioned into well-defined grades. In India (as also in the Punjab), the grading of agricultural produce was started under the Agricultural Produce (Grading and Marketing) Act, 1937. Under this Act, the grading for commodities meant for export was made mandatory, whereas for internal trade it a was kept optional. The progress under the former category is quite encouraging and the commodities, like tobacco, sunn-hemp, wool, bristles, etc., are exported after grading under Agmark. In the case of internal trade, the number of commodities being graded is also large. This list includes butter, ghee, leather, cotton, wheat, mangoes, grapes, apples, pears, eggs, etc. The progress so far under the optional category is very poor. For example, in the case of cotton, out of the total production of 8 lakh bales, only 3100

bales were Agmarked during the year 1969-70. This portion formed only 0.39 per cent of the total cotton produced in the State. Similar was the position in the case of other commodities.

With the improved farm technology, the marked surplus is increasing tremendously, and the fast-developing urbanization has necessitated the transportation of the produce to distant places promptly. As such, the traditional marketing system is becoming more and more inadequate to meet the expanded volume of business. One method to increase efficiency in marketing is to introduce grading and standardization of the produce, so that transactions are conducted with confidence and without any wastage of time through sample or descriptive sales. But it has been found that the producers do not grade their produce on account of the lack of business consiousness. The traders discourage grading, because adultration pays them in the present system of marketing owing to the faulty grade specifications of their own. The grade specifications adopted by the Civil Supplies Department and the Food Corporation of India are meant to achieve the limited object of procuring the produce and supply it at reasonable prices to the consumers. These grade specifications do not cover the produce adequately from the producer's angle. Thus the producers do not get prices commensurate with the quality of their produce. Similarly, warehouses grade the produce to identify the lots of their customers. Thus, the objectives of different agencies dealing in agricultural produce are quite different. Therefore, their grade specifications also do not tally with those of one another. A lot changes its grade while changing the agency. Moreover, the national grades which were prescribed for internal trade do not fit in well with the quality of the produce being received in the markets.

It is, therefore, imperative that the national grades are revised according to the quality of the produce and legislation should be passed to make it obligatory on the buyers and sellers to conduct transactions only according to the prescribed grades. For the effective implementation of the legislation, the banks and warehouses should be asked not to advance any loan to those who bring their produce in the ungraded form.

Transportation

Transportation is one of the important functions of the marketing system concerned with the creation of place utility. Various problems emerging from the transporting of the increased production can be split up into three stages :

(a) From the village to the market;

(b) from the markets to the local godowns and railway stations; and
(c) the transportation to outstations. The last stage will be discussed later.

(*a*) *From the village to the market.* The farmers used various modes of transportation to bring their produce to the market, as detailed in Table 7.4.

TABLE 7.4

Means of transportations used by the farmers in Khanna, Doraha and Ludhiana markets

Means of transportation	Percentage of the wheat transported by each means		
	1968-69	1969-70	1970-71
Bullock-cart	52.2	39.2	38.3
Tractor-trolley	33.1	39.1	47.0
Truck — By producers	3.0	6.0	5.1
Truck — By traders	11.7	15.6	8.0
Poney-cart	..	..	1.6
Total	100	100	100

It may be seen that the percentage share of the cart in transporting wheat is decreasing and that of the tractor-trolley is increasing, because the number of tractors with the cultivators is on the increase. Further, the utilization of the truck by the producers is also increasing because of the development of the approach-roads and the increased marketed surplus with the producers. However, the collection of the produce by truck by the the traders decreased, because during procurement programmes traders did not find it profitable to make purchase from the villages and sell them in the large markets. However, whenever wheat was available at low prices, traders did transport the same by trucks. Again, a new mode of transportation, i.e. the poney-cart, has emerged, because the small farmers cannot hire the tractor-trolleys or trucks and this means of about 10 quintals capacity is suited to such farmers. In the districts of Amritsar and Gurdaspur, this means of transport was already playing an important role.

(b) *From the markets to local godowns and railway station.* Before the introduction of the Mexican wheats, when the volume of arrivals was low, the bullock-carts could serve the purpose of lifting the produce locally in the market towns, but

with the increased arrivals, the carts (a slow-moving means) could not lift the produce efficiently The stocks during 1968-69 remained in the markets for days together and markets were glutted with the unlifted stocks. Sometimes, the markets were closed and no transaction was conducted till the piled-up stocks were removed from the markets. This necessitated the introduction of trucks for the efficient performance of this function. Table 7.5 compares the lifting with these two means during the post-harvest seasons of 1969-70 and 1970-71.

TABLE 7.5

The percentage of the wheat stocks lifted by the carts and trucks from markets to the local godowns and railway stations

Market	Carts		Trucks	
	1969-70	1970-71	1969-70	1970-71
Khanna ..	96	97	4	3
Doraha ..	96	95	2	5
Ludhiana ..	60	60	40	40
Mullanpur ..	80	95	20	5

Before 1969-70, trucks played a negligible part in the transportation of the farm produce. But during 1969-70 and 1970-71, the trucks were engaged to solve the lifting problem.

Number of Commission Agents

The procurement programmes and the increased volume of arrivals provided the commission agents with better incomes. Table 7.6 details the commission earned by the *kacha arhtias* in the Khanna market out of wheat transactions during the post-harvest seasons.

Table 7.6 shows that the commission to *kacha arhtias* by about threefold from 1965-66 to 1967-68 average earnings. It increased further during 1970-71, but the arrivals during the post-harvest season of this year were low, because the rains interrupted the threshing, and the arrivals were delayed. The rapidly rising income to *kacha arhtias* encouraged more firms to enter this business. Table 7.7 compares the number of commission agents working in the selected markets during 1967-68 to 1970-71.

A study of Tables 7.6 and 7.7 will show that the increase (349 per cent) in the case of the income of *kacha arhtias* was

TABLE 7.6

Commission earnings of *kacha arhtias* for wheat transactions in the Khanna Market

Post-harvest period	Volume of arrivals (lacs of quintals)	Value of wheat arrival at averaged price (crores of Rs)	Commission of *kacha arhtias* Rs. 1.50 *ad valorem* basis (lacs of Rs)	Percentage increase in the commission over the average of 1965-66 to 1967-68
Average for 3 years (1965-66 to 1967-68)	2.15	1.47	2.20	..
1968-69	6.15	4.67	7.01	319
1969-70	8.60	6.54	9.81	349
1970-71	7.80	5.93	8.99	309

higher than the increase (88 per cent) in the number of *kacha arhtias* in these markets. Thus their income per head has increased. However, the traders are not shouldering any additonal responsibility for facilitating the marketing of agricultural produce. The increased income of the *kacha arhtias* could not find its investment in improving the market conditions. Most of the grains are still handled by manual labour. Market operations could be performed cheaply through bulk-handling and mechanical devices and the drugery of the labour could be reduced. But this still remains to be ascertained why the commission agents have not improved upon their performance even though proper designs of cleaners suitable for local conditions are available.

TABLE 7.7

The number of commission agents in the selected markets of Ludhiana 1967-68 to 1970-71

Market	The number of commission agents				Percentage increase during 1970-71 over 1967-68
	1967-68	1968-69	1969-70	1970-71	
Khanna	85	96	100	100	18
Doraha	16	19	20	24	33
Ludhiana	88	90	94	94	7
Mullanpur	42	46	48	51	21
Sahnewal	9	11	13	17	88

The lack of interest in the proper care of the produce by the commission agents was also noticeable, when the *kacha*

arhtias did not bother to remove the stocks to a safer place in order to save the grains from rain or flood water during the previous year.

Storage

Before the introduction of high-yielding Mexican wheats, the public agencies had little to store and the necessity of establishing their own godowns was seldom felt. Generally, the individual traders would buy and store the produce.

However, the increased production and the State trading in foodgrains left little scope for a rise in prices during the lean periods. Thus, the traders showed very little interest in purchasing wheat and almost the whole arrivals were procured by the Government. Though these stocks were mainly meant for other consuming States, yet the storage space was essential till they were loaded into the wagons. During 1968-69, the public agencies had little storage capacity and the stocks left after despatches could not be accommodated in the godowns. The stocks had to be kept in the open under tarpaulins. Frequent rains affected the stocks adversely and the moisture content in the stocks covered with tarpaulins increased to 14.35 per cent in the lowest layers of the bags against an admissible limit of 12 per cent. Such stocks were liable to damages during storage or in transit.

During 1970-71, the rains were very early and started right from the harvesting season. Whenever there were sunny days, the electricity being short, the producers could not thresh their wheat efficiently. This state of affairs affected the wheat stocks up to 30 per cent of the total in the threshing-floors and the extent of badly damaged wheat went up to 5 per cent. This was a gross loss to the nation, as this wheat was unfit for human consumption. It is, therefore, critically important that threshing should be done with combines, so that such losses can be avoided. However, the designs of the combines should be made suitable to reap the wheat so low that large stumps are not left behind in the fields. This change in design is important, because majority of the producers cannot afford to lose the *bhusa* at this stage. Further, a regular supply of electricity should be ensured during April and May.

Keeping in view the increasing marketed surplus, the public agencies are increasing their storage capacity, Table 7.8 compares the storage capacity with the public agencies during 1968-69 to 1970-71.

TABLE 7.8

The comparative position of the storage space in selected markets (Ludhiana, Khanna and Doraha)

Year	Storage capacity (000 tonnes)	Percentage increase over the storage capacity of 1968-69
1968-69	11.8	..
1969-70	37.1	228
1970-71	82.9	602

It may be seen that the public agencies extended their storage capacity sixfold. Thus the procured stocks left after despatches could be moved under shelter, if not lifted by the railways. However, the bin-type godowns with the Government are such that they are raised above the ground and have the provision of filling than from the top. This is a time-consuming job and aggravates the glut conditions during the post-harvest seasons. Further, the increasing production demands the extension of public storage to about 2.5 million tonnes in the Punjab State by 1975. Now the storage being scientific, the losses are negligible in the case of public godowns as compared with 3-15 per cent losses in private godowns.[1]

TABLE 7.9

The number of wagons loaded with foodgrains on the broad-gauge in the Punjab markets, 1965-66 to 1968-69

Year	The number of wagons loaded	Percentage increase over the number of wagons loaded in 1964-65
1964-65	51,874	..
1965-66	57,460	11
1966-67	60,661	12
1967-68	75,472	15
1968-69	140,027	170

It may be seen that the number of wagons loaded showed a steady progress up to 1967-68, but it spurted during 1968-69 and about doubled during 1967-68 because of tremendous procurement effort made by the Government and other agencies. But the despatches mostly concentrated in a short period during the post-harvest period mainly owing to:

[1]Kahlon, A.S. 1970. Impact of Changing Conditions on Grain Marketing Institutions and the Structure of Grain Markets in the Erstwhile Punjab. Punjab Agricultural University, Ludhiana. p. 62.

(i) the stocks were procured by the Government, which were needed for other States; and
(ii) the storage facilities with the public agencies were inadequate and they wanted to despatch the stocks directly from the market and also to avoid double charges for handling, storage and transportation costs.

The despatches within a short period being very heavy, the existing facilities of wagon-loading and also that of unloading proved inadequate, for example, the capacity of the sidings for loading the produce. Similarly, the railway goods platforms were also inadequate. Therefore the improvised arrangements were made to load wheat to outstations and this consumed a lot of time, thereby aggravating the labour-storage problems. Also, the sheds being inadequate, the wheat stocks remained exposed to rains and spoilage occurred in many cases.

Processing

The increasing production of foodgrains is bound to pose a serious problem of surplus over the existing demand in the coming years. Processing helps to create a new demand and maintains the quality of the product for a longer period. So far, little processing of foodgrains is done and the produce is sold to the final consumer as such. The consumers themselves process the grains before consumption. This takes a lot of time and effort on the part of the consumers. In the face of the increasing foodgrains production, the prices must eventually come down because of the inelastic demand for foodgrains. The income elasticity of demand for wheat was 0.78 for rural areas and 0.24 for urban areas. However, for maize it was negative (—0.79). To check a crash in prices, efforts to expand demand for various foodgrain products should be made right now. The situation is ripe for immediate action. Urbanization, industrialization and improving educational standards should provide an ideal situation for processed foods. The need is to formulate new processed products (keeping in view the consumer's taste) which could provide instant food to the consumers, who are hard up for time. Thus processing will add a new demand dimension to the agricultural products and the by-products of the processing industry can be used for dairy, poultry and piggery. This will provide a better-quality food to the consumers and cheap foods to cattle and poultry industries, besides adding an element of stability in Indian agriculture which is essential for the economic growth of the country.

From the foregoing discussion it is evident that the existing market structure is inadequate and inefficient in the face of

increased marketed surpluses. Expanded production from year to year will demand efficient handling at the assembling and distribution level. All the existing rigidities, frictions and bottlenecks should be removed to make the marketing system more efficient. The following steps by Government and other agencies can go a long way to remove market imperfections.

1. The market yards from the congested cities be removed to spacious places, encroachments from the existing market yards be removed and markets held in lanes should be provided with regular market yards. The market yards should have raised platform provided with the sheds in the centre so as to protect the produce against rains. Physical improvements in markets should be brought about simultaneously with the provision of link roads to the markets.

2. Cleaning, weighing and stitching of bags need to be mechanized. It will be helpful if bulk handling and transportation of the produce is made obligatory.

3. Cleaning of produce should be done in the villages and market committees should make sure that no charges are made from the producers who bring clean produce to the market.

4. Commercial grading under some well-defined standard should be introduced at all levels to facilitate selling, transportation, storage and processing of the foodgrain products.

5. Keeping in view the storage requirements of foodgrains, oilseeds, fertilizers and insecticides, the scientific storage capacity should be built with space for about 2.5 million tonnes.

6. To avoid gluts in the markets during the post-harvest seasons, the functional rise in prices can help to spread the sales by the producers throughout the year. Further, procurement can be made in villages through the cooperatives and by creating scientific storage facilities at the village level. This will help to despatch the stocks from the villages to the destinations, thereby avoiding gluts and labour problems in the markets during the post-harvest seasons.

7. The traders need to be encouraged to introduce better technology in the market to clean and handle the produce efficiently. Further, the traders can run warehouses and own transportation vehicles for efficient transportation of the produce. The traders need to be encouraged to set up machinery for mechanically handling of agricultural produce at the market level. For this, suitable designs of various types of equipment needed for cleaning, weighing, stitching, etc. should be made available.

8. The railways should expand their loading and unloading facilities, including covered sheds, to provide shelter for goods meant for inward or outward traffic.

9. The processing of agricultural products should be undertaken by public and private agencies to assess the future demand for agricultural products and provide an element of stability to Indian agriculture which is essential for the quick economic growth of the country.

C.F.T.R.I. LIBRARY, MYSORE—13

Acc.No. 181

Call No.

Please return this publication on or before the last DUE DATE stamped below to avoid incurring overdue charges.

Due date	*Return Date*	*Due Date*	*Return Date*